# AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

| 1. CONTRACT ID CODE | PAGE 1 OF 8 PAGES |
|---|---|

| 2. AMENDMENT/MODIFICATION NO. | 3. EFFECTIVE DATE | 4. REQUISITION/PURCHASE REQ. NO. | 5. PROJECT NO. *(If applicable)* |
|---|---|---|---|
| 0001 | 19 AUGUST 2002 | | |

| 6. ISSUED BY CODE | 7. ADMINISTERED BY *(If other than Item 6)* CODE |
|---|---|
| US ARMY ENGINEER DISTRICT, FORT WORTH<br>ATTN: CESWF-CT (RM 2A19)<br>PO BOX 17300<br>FORT WORTH, TX 76102-0300 | |

| 8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)* | (X) | |
|---|---|---|
| | ☒ | 9A. AMENDMENT OF SOLICIATION NO.<br>DACA63-02-B-0009 |
| | | 9B. DATED *(SEE ITEM 11)*<br>29 JULY 2002 |
| | ☐ | 10A. MODIFICATION OF CONTRACT/ORDER NO. |
| | | 10B. DATED *(SEE ITEM 11)* |
| CODE     FACILITY CODE | | |

**11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS**

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a)By completing items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment your desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

**13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS.**
**IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.**

| CHECK ONE | |
|---|---|
| | A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A. |
| | B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b). |
| | C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: |
| | D. OTHER *(Specify type of modification and authority)* |

**E. IMPORTANT:** Contractor ☐ is not, ☐ is required to sign this document and return ______ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (*Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

The Solicitation for COMBINED SQUADRON OPERATIONS/AMU, DYESS AIR FORCE BASE, ABILENE, TEXAS, is amended as follows:

See Continuation Sheets.

NOTE: The Bid Opening Date and Time remain 29 August 2002 at 2 pm local time, as previously announced.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

| 15A. NAME AND TITLE OF SIGNER *(Type or print)* | | 16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)* | |
|---|---|---|---|
| 15B. CONTRACTOR/OFFEROR<br>*(Signature of person authorized to sign)* | 15C. DATE SIGNED | 16B. UNITED STATES OF AMERICA<br>*(Signature of Contracting Officer)* | 16C. DATE SIGNED |

Item 14. Continued.

CHANGES TO BIDDING SCHEDULE

1. Replace the Bidding Schedule, pages 00010-3 through 00010-8, with the accompanying new Bidding Schedule bearing the notation "ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-02-B-0009."

CHANGES TO THE SPECIFICATIONS

2. Section 02220 DEMOLITION - Replace Section 02220 DEMOLITION (Pages 02220-1 thru 02220-4) with the accompanying new Section 02220 DEMOLITION (Pages 02220-1 thru 02220-5), bearing the notation "ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-02-B-0009."

**The photographs accompanying Section 02220 DEMOLITION in the solicitation remain a part of the section and are not deleted.**

3. Section 15075 MECHANICAL IDENTIFICATION - Replace Section 15075 MECHANICAL IDENTIFICATION with the accompanying new Section **15075 IDENTIFICATION OF PIPING**, bearing the notation "ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-02-B-0009."

4. Replacement Sections - Replace the following sections with the accompanying new sections of the same number and title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-02-B-0009:"

| | |
|---|---|
| 01000 | CONSTRUCTION SCHEDULE |
| 01330 | SUBMITTAL PROCEDURES |
| 02315 | EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS |
| 02510 | WATER DISTRIBUTION SYSTEM |
| 02555 | PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM |
| 02721 | SUBBASE COURSES |
| 02722 | AGGREGATE BASE COURSE |
| 02741 | BITUMINOUS PAVING |
| 02763 | PAVEMENT MARKINGS |
| 02925 | ESTABLISHMENT OF TURF |
| 02931 | PLANTING OF TREES, SHRUBS, AND VINES |
| 03100 | STRUCTURAL CONCRETE FORMWORK |
| 04220 | NONBEARING MASONRY VENEER/STEEL STUD WALLS |
| 05120 | STRUCTURAL STEEL |
| 05500 | MISCELLANEOUS METAL |
| 07416 | STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM |
| 07840 | FIRESTOPPING |
| 08110 | STEEL DOORS AND FRAMES |
| 08700 | BUILDERS' HARDWARE |
| 09510 | ACOUSTICAL CEILINGS |
| 10442 | INTERIOR AND EXTERIOR SIGNAGE |
| 13280 | ASBESTOS ABATEMENT |

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| 13284 | REMOVAL, RECYCLING AND DISPOSAL OF REGULATED MATERIALS |
| 13721 | SMALL INTRUSION DETECTION SYSTEM |
| 13851 | FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE |
| 13930 | WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION |
| 15080 | THERMAL INSULATION FOR MECHANICAL SYSTEMS |
| 15181 | CHILLED AND CONDENSER WATER PIPING AND ACCESSORIES |
| 15182 | REFRIGERANT PIPING |
| 15190 | GAS PIPING SYSTEMS |
| 15400 | PLUMBING, GENERAL PURPOSE |
| 15556 | FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS |
| 15569 | WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH |
| 15620 | LIQUID CHILLERS |
| 15895 | AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM |
| 15952 | DIRECT DIGITAL CONTROL SYSTEM FOR DYESS AFB |
| 15995 | COMMISSIONING OF HVAC SYSTEMS |
| 16375 | ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND |
| 16770 | PUBLIC ADDRESS SYSTEMS |

CHANGES TO DRAWINGS

5. New Drawings.- The new drawings listed below which accompany this amendment, bearing the notation "AM #0001" shall be added to and become a part of the contract documents:

| | | |
|---|---|---|
| M063_1.CAL | Seq 231a M6.3 | MECHANICAL DETAILS |
| P042_1.CAL | Seq 238a P4.2 | PLUMBING DETAILS |
| P043_1.CAL | Seq 238b P4.3 | PLUMBING SCHEDULES AND DETAILS |

6. Replacement Drawings.- Replace the drawings listed below with the attached new drawings of the same number, bearing the notation "AM #0001":

| | | | |
|---|---|---|---|
| G000_1.CAL | Seq 0 | 0 | COVER SHEET |
| G002_1.CAL | Seq 2 | T-2 | INDEX TO DRAWINGS |
| G003_1.CAL | Seq 3 | T-3 | PROJECT LOCATION PLAN |
| AB011_1.CAL | Seq 7 | AB1.1 | BUILDING 4214 ABATEMENT PLAN |
| AB012_1.CAL | Seq 8 | AB1.2 | BUILDING 4215 ABATEMENT PLAN |
| AB013_1.CAL | Seq 9 | AB1.3 | BUILDING 4301 ABATEMENT PLAN |
| AB014_1.CAL | Seq 10 | AB1.4 | BUILDING 4302 ABATEMENT PLAN |
| C001_1.CAL | Seq 11 | C1 | DEMOLITION PLAN |
| C002_1.CAL | Seq 12 | C2 | BUILDING 4214 - DEMOLITION PLAN |
| C003_1.CAL | Seq 13 | C3 | BUILDING 4214 - FOUNDATION DEMOLITION PLAN |
| C004_1.CAL | Seq 14 | C4 | BUILDING 4215 - DEMOLITION PLAN |
| C005_1.CAL | Seq 15 | C5 | BUILDING 4301 - DEMOLITION PLAN |
| C006_1.CAL | Seq 16 | C6 | BUILDING 4215 AND 4301 - FOUNDATION DEMOLITION PLANS |
| C007_1.CAL | Seq 17 | C7 | BUILDING 4302 - DEMOLITION PLAN |
| C008_1.CAL | Seq 18 | C8 | BUILDING 4302 - FOUNDATION DEMOLITION PLAN |
| C009_1.CAL | Seq 19 | C9 | PICNIC SHELTERS AND BUS SHELTER - DEMOLTION PLANS |
| C010_1.CAL | Seq 20 | C10 | SURVEY CONTROL PLAN |
| C011_1.CAL | Seq 21 | C11 | LAYOUT PLAN |

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|---|---|---|---|
| C012_1.CAL | Seq 22 | C12 | PARKING AREAS LAYOUT PLANS |
| C013_1.CAL | Seq 23 | C13 | PAVING PLAN |
| C014_1.CAL | Seq 24 | C14 | GRADING PLAN |
| C015_1.CAL | Seq 25 | C15 | ROOF DRAIN PLAN |
| C016_1.CAL | Seq 26 | C16 | CONCRETE PAVEMENT JOINT LAYOUT PLAN |
| C017_1.CAL | Seq 27 | C17 | CONCRETE PAVEMENT FINISHED SPOT ELEVATIONS |
| C018_1.CAL | Seq 28 | C18 | UTILITY PLAN |
| C019_1.CAL | Seq 29 | C19 | CONSTRUCTION FENCE LAYOUT PLAN |
| C020_1.CAL | Seq 30 | C20 | ACCESS DRIVE A - PLAN AND PROFILE |
| C021_1.CAL | Seq 31 | C21 | ACCESS DRIVE B - PLAN AND PROFILE |
| C022_1.CAL | Seq 32 | C22 | STORM DRAIN LINE A - PLAN AND PROFILE |
| C023_1.CAL | Seq 33 | C23 | STORM DRAIN LINES A-1 AND A-2 - PLAN AND PROFILE |
| C024_1.CAL | Seq 34 | C24 | STORM DRAIN LINE A-3 - PLAN AND PROFILE |
| C026_1.CAL | Seq 36 | C26 | SANITARY SEWER LINE A - PLAN AND PROFILE |
| C027_1.CAL | Seq 37 | C27 | SANITARY SEWER LINE B - PLAN AND PROFILE |
| C028_1.CAL | Seq 38 | C28 | WATER LINES A AND B - PLAN AND PROFILE |
| C029_1.CAL | Seq 39 | C29 | WATER LINE C - PLAN AND PROFILE |
| C030_1.CAL | Seq 40 | C30 | GAS LINE A - PLAN AND PROFILE |
| C031_1.CAL | Seq 41 | C31 | GAS LINE A-1 - PLAN AND PROFILE |
| C033_1.CAL | Seq 43 | C33 | ELECTRICAL LINE - PLAN AND PROFILE |
| C034_1.CAL | Seq 44 | C34 | COMMUNICATIONS LINE - PLAN AND PROFILE |
| C037_1.CAL | Seq 47 | C37 | MECHANICAL YARD PLAN AND DETAILS |
| C039_1.CAL | Seq 49 | C39 | PAVING DETAILS II |
| C040_1.CAL | Seq 50 | C40 | PAVING DETAILS III |
| C041_1.CAL | Seq 51 | C41 | PAVING DETAILS IV |
| C042_1.CAL | Seq 52 | C42 | SANITARY SEWER DETAILS |
| C045_1.CAL | Seq 55 | C45 | FENCE DETAILS |
| C046_1.CAL | Seq 56 | C46 | SLIDING GATE DETAILS |
| C047_1.CAL | Seq 57 | C47 | SLIDING GATE OPERATOR DETAILS |
| C049_1.CAL | Seq 59 | C49 | STORM WATER POLLUTION PREVENTION PLAN |
| C051_1.CAL | Seq 61 | C51 | ELECTRICAL DEMOLITION SITE PLAN |
| C052_1.CAL | Seq 62 | C52 | ELECTRICAL SITE PLAN |
| C053_1.CAL | Seq 63 | C53 | EXTERIOR ELECTRICAL DETAILS I |
| C054_1.CAL | Seq 64 | C54 | EXTERIOR ELECTRICAL DETAILS II |
| C057_1.CAL | Seq 67 | C57 | BID OPTION #5 - CIRCULAR DRIVE LAYOUT PLAN AND DETAILS |
| C058_1.CAL | Seq 68 | C58 | "BID OPTION #7 - GOV PARKING LAYOUT, GRADING AND ELECTRICAL PLANS" |
| C060_1.CAL | Seq 70 | C60 | BID OPTION #8 - ELECTRICAL SITE PLAN |
| C061_1.CAL | Seq 71 | C61 | BID OPTION #8 - ELECTRICAL LINE B - PLAN AND PROFILE |
| C062_1.CAL | Seq 72 | C62 | BID OPTION #8 - EXTERIOR ELECTRICAL DETAILS |
| L011_1.CAL | Seq 73 | L1.1 | PLANTING PLAN |
| L012_1.CAL | Seq 74 | L1.2 | PLANTING PLAN - BID OPTION #6 |
| L021_1.CAL | Seq 76 | L2.1 | IRRIGATION PLAN |
| L022_1.CAL | Seq 77 | L2.2 | IRRIGATION PLAN - BID OPTION #6 |
| L031_1.CAL | Seq 79 | L3.1 | PATIO PLAN - BID OPTION #4 |
| L032_1.CAL | Seq 80 | L3.2 | PATIO SHELTER DETAILS - BID OPTION #4 |
| A011_1.CAL | Seq 81 | A1.1 | OVERALL FLOOR PLAN |
| A012_1.CAL | Seq 82 | A1.2 | FLOOR PLAN - AREA A |
| A013_1.CAL | Seq 83 | A1.3 | FLOOR PLAN - AREA B |
| A014_1.CAL | Seq 84 | A1.4 | FLOOR PLAN - AREA C AND MEZZANINE FLOOR PLAN |
| A015_1.CAL | Seq 85 | A1.5 | FLOOR PLAN - AREA D |
| A016_1.CAL | Seq 86 | A1.6 | FLOOR PLAN - AREA E |
| A017_1.CAL | Seq 87 | A1.7 | FLOOR PLAN - AREA F |
| A021_1.CAL | Seq 88 | A2.1 | OVERALL REFLECTED CEILING PLAN |

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| A022_1.CAL | Seq 89 | A2.2 | REFLECTED CEILING PLAN - AREA A |
| A023_1.CAL | Seq 90 | A2.3 | REFLECTED CEILING PLAN - AREA B |
| A024_1.CAL | Seq 91 | A2.4 | REFLECTED CEILING PLAN - AREA C AND MEZZANINE FLOOR PLAN |
| A025_1.CAL | Seq 92 | A2.5 | REFLECTED CEILING PLAN - AREA D |
| A026_1.CAL | Seq 93 | A2.6 | REFLECTED CEILING PLAN - AREA E |
| A027_1.CAL | Seq 94 | A2.7 | REFLECTED CEILING PLAN - AREA F |
| A028_1.CAL | Seq 95 | A2.8 | INTERMEDIATE SUSPENSION LEVEL PLAN AND DETAILS |
| A029_1.CAL | Seq 96 | A2.9 | CEILING DETAILS |
| A031_1.CAL | Seq 97 | A3.1 | LIFE SAFETY PLAN |
| A041_1.CAL | Seq 98 | A4.1 | ROOF PLAN |
| A042_1.CAL | Seq 99 | A4.2 | ROOF DETAILS |
| A043_1.CAL | Seq 100 | A4.3 | ROOF DETAILS |
| A044_1.CAL | Seq 101 | A4.4 | ROOF DETAILS |
| A045_1.CAL | Seq 102 | A4.5 | ROOF DETAILS |
| A046_1.CAL | Seq 103 | A4.6 | ROOF DETAILS |
| A051_1.CAL | Seq 104 | A5.1 | EAST AND WEST EXTERIOR ELEVATIONS |
| A052_1.CAL | Seq 105 | A5.2 | "SOUTH, NORTH, WEST AND EAST EXTERIOR ELEVATIONS" |
| A053_1.CAL | Seq 106 | A5.3 | MAIN AND FLIGHT LINE ENTRY ELEVATIONS |
| A061_1.CAL | Seq 107 | A6.1 | BUILDING SECTIONS |
| A063_1.CAL | Seq 109 | A6.3 | "MOBAG SHELTER PLANS, ELEVATIONS AND DETAILS - BID OPTIONS #3" |
| A064_1.CAL | Seq 110 | A6.4 | SECTION AT ENTRY OVERHANG |
| A065_1.CAL | Seq 111 | A6.5 | SECTION AT MAIN ENTRY |
| A071_1.CAL | Seq 112 | A7.1 | ENLARGED PLANS AND INTERIOR ELEVATIONS |
| A072_1.CAL | Seq 113 | A7.2 | INTERIOR ELEVATIONS |
| A073_1.CAL | Seq 114 | A7.3 | INTERIOR ELEVATIONS AND DETAILS |
| A074_1.CAL | Seq 115 | A7.4 | ENLARGED PLANS AND INTERIOR ELEVATIONS |
| A075_1.CAL | Seq 116 | A7.5 | ENLARGED PLANS AND INTER ELEVATIONS |
| A076_1.CAL | Seq 117 | A7.6 | BUILDING DIRECTORY ELEVATION |
| A077_1.CAL | Seq 118 | A7.7 | "FURNITURE PLAN, BID OPTIONS #9, #10 AND #16" |
| A078_1.CAL | Seq 119 | A7.8 | "HERITAGE CASEWORK, ELEVATIONS AND SECTIONS" |
| A081_1.CAL | Seq 120 | A8.1 | FINISH SELECTIONS |
| A082_1.CAL | Seq 121 | A8.2 | FINISH SCHEDULE #1 |
| A083_1.CAL | Seq 122 | A8.3 | FINISH SCHEDULE #2 |
| A085_1.CAL | Seq 124 | A8.5 | FINISH PLANS AND ELEVATIONS |
| A086_1.CAL | Seq 125 | A8.6 | FINISH PLANS |
| A087_1.CAL | Seq 126 | A8.7 | FINISH PLANS |
| A091_1.CAL | Seq 127 | A9.1 | INTERIOR WALL TYPES AND DETAILS |
| A092_1.CAL | Seq 128 | A9.2 | EXTERIOR WALL SECTIONS |
| A093_1.CAL | Seq 129 | A9.3 | EXTERIOR WALL SECTIONS |
| A094_1.CAL | Seq 130 | A9.4 | EXTERIOR WALL SECTIONS |
| A0911_1.CAL | Seq 137 | A9.11 | COLUMN PLANS |
| A101_1.CAL | Seq 138 | A10.1 | DOOR SCHEDULE #1 AND DOOR TYPES |
| A102_1.CAL | Seq 139 | A10.2 | DOOR SCHEDULE #2 AND DOOR TYPES |
| A103_1.CAL | Seq 140 | A10.3 | DOOR SCHEDULE #3 AND DOOR TYPES |
| A104_1.CAL | Seq 141 | A10.4 | EXTERIOR AND INTERIOR WINDOW ELEVATIONS AND DETAILS |
| A105_1.CAL | Seq 142 | A10.5 | EXTERIOR STOREFRONT ELEVATIONS AND DETAILS |
| A106_1.CAL | Seq 143 | A10.6 | TRANSLUCENT PANEL ELEVATIONS AND DETAILS |
| A108_1.CAL | Seq 145 | A10.8 | INTERIOR DOOR FRAME DETAILS |
| A109_1.CAL | Seq 146 | A10.9 | DOOR FRAME DETAILS |
| A1010_1.CAL | Seq 147 | A10.10 | DOOR FRAME DETAILS |

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| A1011_1.CAL | Seq 148 | A10.11 | DOOR FRAME DETAILS |
| S001_1.CAL | Seq 149 | S0.1 | STRUCTURAL GENERAL NOTES |
| S002_1.CAL | Seq 150 | S0.2 | WIND LOAD DIAGRAM AND ROOF DECK PLAN |
| S003_1.CAL | Seq 151 | S0.3 | TYPICAL CONCRETE DETAILS |
| S004_1.CAL | Seq 152 | S0.4 | TYPICAL CONCRETE DETAILS |
| S005_1.CAL | Seq 153 | S0.5 | TYPICAL STEEL AND MISCELLANEOUS DETAILS |
| S011_1.CAL | Seq 154 | S1.1 | DRILLED PIER PLAN - AREA A |
| S012_1.CAL | Seq 155 | S1.2 | DRILLED PIER PLAN - AREA B |
| S013_1.CAL | Seq 156 | S1.3 | DRILLED PIER PLAN - AREA C |
| S014_1.CAL | Seq 157 | S1.4 | DRILLED PIER PLAN - AREA D |
| S015_1.CAL | Seq 158 | S1.5 | DRILLED PIER PLAN - AREA E |
| S016_1.CAL | Seq 159 | S1.6 | DRILLED PIER PLAN - AREA F |
| S017_1.CAL | Seq 160 | S1.7 | FOUNDATION PLAN - AREA A |
| S018_1.CAL | Seq 161 | S1.8 | FOUNDATION PLAN - AREA B |
| S019_1.CAL | Seq 162 | S1.9 | FOUNDATION PLAN - AREA C |
| S110_1.CAL | Seq 163 | S1.10 | FOUNDATION PLAN - AREA D |
| S111_1.CAL | Seq 164 | S1.11 | FOUNDATION PLAN - AREA E |
| S112_1.CAL | Seq 165 | S1.12 | FOUNDATION PLAN - AREA F |
| S113_1.CAL | Seq 166 | S1.13 | FLOOR SLAB PLAN - AREA A |
| S114_1.CAL | Seq 167 | S1.14 | FLOOR SLAB PLAN - AREA B |
| S115_1.CAL | Seq 168 | S1.15 | FLOOR SLAB PLAN - AREA C |
| S116_1.CAL | Seq 169 | S1.16 | FLOOR SLAB PLAN - AREA D |
| S117_1.CAL | Seq 170 | S1.17 | FLOOR SLAB PLAN - AREA E |
| S118_1.CAL | Seq 171 | S1.18 | FLOOR SLAB PLAN - AREA F |
| S021_1.CAL | Seq 172 | S2.1 | ROOF PLAN - AREA A |
| S022_1.CAL | Seq 173 | S2.2 | ROOF PLAN - AREA B |
| S023_1.CAL | Seq 174 | S2.3 | ROOF PLAN - AREA C |
| S024_1.CAL | Seq 175 | S2.4 | ROOF PLAN - AREA D |
| S025_1.CAL | Seq 176 | S2.5 | ROOF PLAN - AREA E |
| S026_1.CAL | Seq 177 | S2.6 | ROOF PLAN - AREA F |
| S031_1.CAL | Seq 178 | S3.1 | FRAME ELEVATIONS |
| S032_1.CAL | Seq 179 | S3.2 | FRAME ELEVATIONS |
| S033_1.CAL | Seq 180 | S3.3 | FRAME ELEVATIONS |
| S034_1.CAL | Seq 181 | S3.4 | FRAME ELEVATIONS |
| S035_1.CAL | Seq 182 | S3.5 | FRAME ELEVATIONS |
| S041_1.CAL | Seq 183 | S4.1 | FOUNDATION SCHEDULES AND DETAILS |
| S042_1.CAL | Seq 184 | S4.2 | FOUNDATION SECTIONS AND DETAILS |
| S043_1.CAL | Seq 185 | S4.3 | FOUNDATION SECTIONS AND DETAILS |
| S044_1.CAL | Seq 186 | S4.4 | "FOUNDATIONS PARTIAL PLAN, SECTIONS AND DETAILS" |
| S045_1.CAL | Seq 187 | S4.5 | FOUNDATION SECTIONS AND DETAILS |
| S046_1.CAL | Seq 188 | S4.6 | FOUNDATION PILASTER DETAILS |
| S051_1.CAL | Seq 189 | S5.1 | TYPICAL MASONRY DETAILS |
| S052_1.CAL | Seq 190 | S5.2 | MASONRY DETAILS |
| S053_1.CAL | Seq 191 | S5.3 | MASONRY DETAILS |
| S061_1.CAL | Seq 192 | S6.1 | TYPICAL CONNECTION DETAILS |
| S062_1.CAL | Seq 193 | S6.2 | FRAME SECTIONS AND DETAILS |
| S063_1.CAL | Seq 194 | S6.3 | FRAME SECTIONS AND DETAILS |
| S064_1.CAL | Seq 195 | S6.4 | FRAME SECTIONS AND DETAILS |
| S065_1.CAL | Seq 196 | S6.5 | FRAME SECTIONS AND DETAILS |
| S066_1.CAL | Seq 197 | S6.6 | FRAME SECTIONS AND DETAILS |
| S067_1.CAL | Seq 198 | S6.7 | TYPICAL BASE PLATE DETAILS |
| M001_1.CAL | Seq 199 | M0.1 | MECHANICAL/PLUMBING LEGEND |
| M002_1.CAL | Seq 200 | M0.2 | MECHANICAL SCHEDULES |

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| M003_1.CAL | Seq 201 | M0.3 | MECHANICAL SCHEDULES |
| M004_1.CAL | Seq 202 | M0.4 | MECHANICAL SCHEDULES |
| M011_1.CAL | Seq 203 | M1.1 | HVAC FLOOR PLAN - AREA A |
| M012_1.CAL | Seq 204 | M1.2 | HVAC FLOOR PLAN - AREA B |
| M013_1.CAL | Seq 205 | M1.3 | HVAC FLOOR PLAN - AREA C |
| M014_1.CAL | Seq 206 | M1.4 | HVAC FLOOR PLAN - AREA D |
| M015_1.CAL | Seq 207 | M1.5 | HVAC FLOOR PLAN - AREA E |
| M016_1.CAL | Seq 208 | M1.6 | HVAC FLOOR PLAN - AREA F |
| M017_1.CAL | Seq 209 | M2.1 | PIPING FLOOR PLAN - AREA A |
| M022_1.CAL | Seq 210 | M2.2 | PIPING FLOOR PLAN - AREA B |
| M023_1.CAL | Seq 211 | M2.3 | PIPING FLOOR PLAN - AREA C |
| M024_1.CAL | Seq 212 | M2.4 | PIPING FLOOR PLAN - AREA D |
| M025_1.CAL | Seq 213 | M2.5 | PIPING FLOOR PLAN - AREA E |
| M026_1.CAL | Seq 214 | M2.6 | PIPING FLOOR PLAN - AREA F |
| M031_1.CAL | Seq 215 | M3.1 | ENLARGED MECHANICAL ROOM 143 PLAN |
| M032_1.CAL | Seq 216 | M3.2 | ENLARGED MECHANICAL ROOM 243 PLAN |
| M033_1.CAL | Seq 217 | M3.3 | MECHANICAL MEZZANINE PLAN |
| M034_1.CAL | Seq 218 | M3.4 | MECHANICAL SECTIONS |
| M035_1.CAL | Seq 219 | M3.5 | MECHANICAL SECTIONS |
| M041_1.CAL | Seq 221 | M4.1 | HEATING AND CHILLED WATER SYSTEM SCHEMATICS |
| M052_1.CAL | Seq 223 | M5.2 | CONTROL SYSTEM ARCHITECTURE |
| M053_1.CAL | Seq 224 | M5.3 | "AHU-1, 2 CONTROL SEQUENCE" |
| M054_1.CAL | Seq 225 | M5.4 | "AHU-1, 2 CONTROL SCHEDULES" |
| M055_1.CAL | Seq 226 | M5.5 | "AHU-3, 4 CONTROL SEQUENCE" |
| M056_1.CAL | Seq 227 | M5.6 | AHU-5 CONTROL SEQUENCE |
| M057_1.CAL | Seq 228 | M5.7 | HEATING AND CHILLED WATER SYSTEM SCHEMATICS |
| M058_1.CAL | Seq 229 | M5.8 | HEATING AND CHILLED WATER SYSTEM CONTROLS |
| M061_1.CAL | Seq 230 | M6.1 | MECHANICAL DETAILS |
| M062_1.CAL | Seq 231 | M6.2 | MECHANICAL DETAILS |
| P010_1.CAL | Seq 233 | P1.0 | OVERALL FOUNDATION PLAN - PLUMBING |
| P011_1.CAL | Seq 234 | P1.1 | OVERALL FLOOR PLAN - PLUMBING |
| P021_1.CAL | Seq 235 | P2.1 | ENLARGED FLOOR PLANS |
| P031_1.CAL | Seq 236 | P3.1 | WASTE AND VENT ISOMETRIC |
| P032_1.CAL | Seq 237 | P3.2 | DOMESTIC WATER ISOMETRIC |
| P041_1.CAL | Seq 238 | P4.1 | PLUMBING SCHEDULES AND DETAILS |
| FP010_1.CAL | Seq 239 | FP1.0 | FIRE PROTECTION DESIGN PARAMETERS |
| FP011_1.CAL | Seq 240 | FP1.1 | FIRE PROTECTION DESIGN |
| FP012_1.CAL | Seq 241 | FP1.2 | OVERALL FIRE PROTECTION PLAN |
| FP020_1.CAL | Seq 242 | FP2.0 | SPRINKLER SCHEDULES |
| E001_1.CAL | Seq 243 | E0.1 | ELECTRICAL LEGEND AND ABBREVIATIONS |
| E011_1.CAL | Seq 244 | E1.1 | ONE-LINE DIAGRAM |
| E012_1.CAL | Seq 245 | E1.2 | FEEDER AND PANEL SCHEDULES |
| E013_1.CAL | Seq 246 | E1.3 | PANEL SCHEDULE |
| E014_1.CAL | Seq 247 | E1.4 | PANEL SCHEDULE |
| E015_1.CAL | Seq 248 | E1.5 | PANEL SCHEDULE |
| E016_1.CAL | Seq 249 | E1.6 | PANEL AND EQUIPMENT CONNECTION SCHEDULE |
| E017_1.CAL | Seq 250 | E1.7 | EQUIPMENT CONNECTION SCHEDULE CONTINUED |
| E110_1.CAL | Seq 253 | E1.10 | LIGHTING FIXTURE DETAILS |
| E111_1.CAL | Seq 254 | E1.11 | LIGHTING FIXTURE DETAILS |
| E021_1.CAL | Seq 255 | E2.1 | LIGHTING FLOOR PLAN - AREA A |
| E022_1.CAL | Seq 256 | E2.2 | LIGHTING FLOOR PLAN - AREA B |
| E023_1.CAL | Seq 257 | E2.3 | LIGHTING FLOOR PLAN - AREA C |
| E024_1.CAL | Seq 258 | E2.4 | LIGHTING FLOOR PLAN - AREA D |
| E026_1.CAL | Seq 260 | E2.6 | LIGHTING FLOOR PLAN - AREA F |

| | | | |
|---|---|---|---|
| E027_1.CAL | Seq 261 | E2.7 | ENLARGED LIGHTING PLAN - MAIN BRIEFING ROOM |
| E028_1.CAL | Seq 262 | E2.8 | PATIO LIGHTING PLAN |
| E031_1.CAL | Seq 263 | E3.1 | POWER FLOOR PLAN - AREA A |
| E032_1.CAL | Seq 264 | E3.2 | POWER FLOOR PLAN - AREA B |
| E033_1.CAL | Seq 265 | E3.3 | POWER FLOOR PLAN - AREA C |
| E034_1.CAL | Seq 266 | E3.4 | POWER FLOOR PLAN - AREA D |
| E035_1.CAL | Seq 267 | E3.5 | POWER FLOOR PLAN - AREA E |
| E036_1.CAL | Seq 268 | E3.6 | POWER FLOOR PLAN - AREA F |
| E037_1.CAL | Seq 269 | E3.7 | ENLARGED ELECTRICAL ROOM PLANS AND ELEVATIONS |
| E038_1.CAL | Seq 270 | E3.8 | ENLARGED MECHANICAL ROOM POWER PLANS |
| E041_1.CAL | Seq 271 | E4.1 | "VOICE/DATA, PA, CATV, AND CABLE TRAY PLAN - AREA A" |
| E042_1.CAL | Seq 272 | E4.2 | "VOICE/DATA, PA, CATV, AND CABLE TRAY PLAN - AREA B" |
| E043_1.CAL | Seq 273 | E4.3 | "VOICE/DATA, PA, CATV, AND CABLE TRAY PLAN - AREA C" |
| E044_1.CAL | Seq 274 | E4.4 | "VOICE/DATA, PA, CATV, AND CABLE TRAY PLAN - AREA D" |
| E045_1.CAL | Seq 275 | E4.5 | "VOICE/DATA, PA, CATV, AND CABLE TRAY PLAN - AREA E" |
| E046_1.CAL | Seq 276 | E4.6 | "VOICE/DATA, PA, CATV, AND CABLE TRAY PLAN - AREA F" |
| E047_1.CAL | Seq 277 | E4.7 | FIRE ALARM AND SECURITY SYSTEMS PLAN - AREA A |
| E048_1.CAL | Seq 278 | E4.8 | FIRE ALARM AND SECURITY SYSTEMS PLAN - AREA B |
| E049_1.CAL | Seq 279 | E4.9 | FIRE ALARM AND SECURITY SYSTEMS PLAN - AREA C |
| E410_1.CAL | Seq 280 | E4.10 | FIRE ALARM AND SECURITY SYSTEMS PLAN - AREA D |
| E411_1.CAL | Seq 281 | E4.11 | FIRE ALARM AND SECURITY SYSTEMS PLAN - AREA E |
| E412_1.CAL | Seq 282 | E4.12 | FIRE ALARM AND SECURITY SYSTEMS PLAN - AREA F |
| E413_1.CAL | Seq 283 | E4.13 | COMMUNICATIONS ROOMS - ENLARGED PLANS |
| E051_1.CAL | Seq 284 | E5.1 | LIGHTNING PROTECTION PLAN |
| E052_1.CAL | Seq 285 | E5.2 | LIGHTNING PROTECTION AND GROUNDING DETAILS |
| E053_1.CAL | Seq 286 | E5.3 | GROUNDING RISER DIAGRAM |
| E054_1.CAL | Seq 287 | E5.4 | ELECTRICAL GROUNDING DETAILS |
| E061_1.CAL | Seq 288 | E6.1 | PARTIAL VOICE SYSTEM RISER DIAGRAM - NORTH |
| E062_1.CAL | Seq 289 | E6.2 | PARTIAL VOICE SYSTEM RISER DIAGRAM - SOUTH |
| E063_1.CAL | Seq 290 | E6.3 | PARTICAL DATA SYSTEM RISER DIAGRAM - NORTH |
| E064_1.CAL | Seq 291 | E6.4 | PARTICAL DATA SYSTEM RISER DIAGRAM - SOUTH |
| E065_1.CAL | Seq 292 | E6.5 | FIRE DETECTION AND ALARM SYSTEM RISER DIAGRAM |
| E066_1.CAL | Seq 293 | E6.6 | AUDIO SYSTEM RISER DIAGRAM |
| E067_1.CAL | Seq 294 | E6.7 | AUDIO SYSTEM RISER DIAGRAM CONTINUATION AND DETAILS |
| E071_1.CAL | Seq 295 | E7.1 | ELECTRICAL DETAILS |
| E072_1.CAL | Seq 296 | E7.2 | ELECTRICAL DETAILS |

END OF AMENDMENT

BIDDING SCHEDULE (cont)

(To be attached to SF 1442)

| Item No. | Description | Estimated Quantity | Unit | Unit Price | Estimated Amount |
|---|---|---|---|---|---|
| Base Bid: All work required by the Contract documents for the construction of the Dyess Air Force Base Combined Squadron Operation Facility/AMU excluding Option Bid Items. | | | | | |
| 0001 | Combined Squadron Operation Facility/AMU complete, including utilities to the 1524mm (5-ft) line, and exclusive of all other work listed separately. | Job | Sum | *** | $_______ |
| 0002 | Drilled Piers | | | | |
| 0002AA | 457mm (18-In) Drilled Piers | 183 | LM | $_____ | $_______ |
| 0002AB | 610mm (24-In) Drilled Piers | 67 | LM | $_____ | $_______ |
| 0002AC | 762mm (30-In) Drilled Piers | 608 | LM | $_____ | $_______ |
| 0002AD | 915mm (36-In) Drilled Piers | 589 | LM | $_____ | $_______ |
| 0002AE | 1067mm (42-In) Drilled Piers | 252 | LM | $_____ | $_______ |
| 0002AF | 1220mm (48-In) Drilled Piers | 76 | LM | $_____ | $_______ |
| 0002AG | 1372mm (54-In) Drilled Piers | 19 | LM | $_____ | $_______ |
| 0003 | All work required by the plans and specifications for the Demolition of existing buildings P4302, P4214, P4301, and P4215 (Including partial foundations and all utilities to the 1524mm (5 ft) line) | | | | |
| 0003AA | Utility Poles Abatement and Disposal | 5 | EA | $_____ | $_________ |
| 0003AB | Fluorescent Light Fixtures Abatement and Disposal | 542 | EA | $_____ | $_________ |
| 0003AC | Mercury Switches Abatement and Disposal | 5 | EA | $_____ | $_________ |
| 0003AD | Lead based paint Abatement and Disposal | 67.3 | SM | $_____ | $_________ |
| 0003AE | Asbestos containing floor tile Abatement and Disposal | 13.96 | SM | $_____ | $_________ |

Combined Squadron Operations Facility/AMU
Dyess Air Force Base, Abilene, Texas

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BIDDING SCHEDULE (cont)

| Item No. | Description | Estimated Quantity | Unit | Unit Price | Estimated Amount |
|---|---|---|---|---|---|
| 0003 AF | Demolition and disposal of existing buildings, concrete foundations, and drilled piers down 2.0 meters | Job | *** | *** | $_________ |
| 0004 | Construct Typical Pier "Fix" as detailed on Drawing S1.7, Sections 1 and 2. | 5 | EA | $_____ | $_________ |
| 0005 | Construct all Exterior Work outside the building's 1524mm(5 ft) line (Including utilities, earthwork, paving, sidewalk, parking lot paving, curb and gutter, hardstand paving, fencing, screen walls, and all other work not listed separately) | Job | Sum | *** | $_________ |
| 0006 | Final Record Drawings | Job | Sum | *** | $ 55,000.00 |

TOTAL BASE BID $________________

BIDDING SCHEDULE (cont)

| Item No. | Description | Estimated Quantity | Unit | Unit Price | Estimated Amount |
|---|---|---|---|---|---|
| 0007 | OPTION NO. 1: All work required by the plans and specifications to provide the canopy structure along the flightline side of the building. | Job | Sum | *** | $__________ |
| 0008 | OPTION NO. 2: All work required by the plans and specifications to provide the lightning protection system. | Job | Sum | *** | $__________ |
| 0009 | OPTION NO. 3: All work required by the plans and specifications to construct the MOBAG shelters and foundations. | Job | Sum | *** | $__________ |
| 0010 | OPTION NO. 4: All work required by the plans and specifications to construct all patio flatwork, barbeque grilles, and trellis structures. | Job | Sum | *** | $__________ |
| 0011 | OPTION NO. 5: All work required by the plans and specifications to construct the circular drive in front of the building. | Job | Sum | *** | $__________ |
| 0012 | OPTION NO. 6: All work required by the plans and specifications for the Landscaping. Includes irrigation for landscaping, trees, and shrubs. | Job | Sum | *** | $__________ |
| 0013 | OPTION NO. 7: All work required by the plans and specifications to construct the GOV parking. | Job | Sum | *** | $__________ |
| 0014 | OPTION NO. 8: All work required by the plans and specifications to provide the primary loop. | Job | Sum | *** | $__________ |
| 0015 | OPTION NO. 9: Not Used | | | | |
| 0016 | OPTION NO. 10: Not Used | | | | |
| 0017 | OPTION NO. 11: All work required by the plans and specifications to provide the metal lockers. | Job | Sum | *** | $__________ |

TOTAL BASE BID PLUS OPTIONS 1 THRU 11 $_______________

BIDDING SCHEDULE (cont)

0018 The monetary value for warranty work is established at 1 percent of the amount awarded for construction. See the Contract Specifications Section 01770 CONTRACT CLOSEOUT, paragraph “Contractor's Response to Construction Warranty Service Requirements.”

NOTES:

1. ARITHMETIC DISCREPANCIES (EFARS 14.407-2)

(a) For the purpose of initial evaluation of bids, the following will be utilized in resolving arithmetic discrepancies found on the face of the bidding schedule as submitted by bidders:

(1) Obviously misplaced decimal points will be corrected;

(2) In case of discrepancy between unit price and extended price, the unit price will govern;

(3) Apparent errors in extension of unit prices will be corrected; and

(4) Apparent errors in addition of lump-sum and extended prices will be corrected.

(b) For the purpose of bid evaluation, the Government will proceed on the assumption that the bidder intends his bid to be evaluated on the basis of the unit prices, the totals arrived at by resolution of arithmetic discrepancies as provided above and the bid will be so reflected on the abstract of bids.

(c) These correction procedures shall not be used to resolve any ambiguity concerning which bid is low.

2. If a modification to a bid based on unit prices is submitted, which provides for a lump sum adjustment to the total estimated cost, the application of the lump sum adjustment to each unit price in the bid schedule must be stated. If it is not stated, the bidder agrees that the lump sum adjustment shall be applied on a pro rata basis to every unit price in the bid schedule.

3. Bidders must bid on all items.

4. Costs attributable to Division 01 - General Requirements is assumed to be prorated among bid items listed.

5. Responders are advised that this project may be delayed, cancelled or revised at any time during the solicitation, selection, evaluation, negotiation and/or final award process based on decisions related to DOD changes in force structure and disposition of the Armed Forces.

BIDDING SCHEDULE (cont)

6. For the purpose of this solicitation, the word "item" shall be considered to mean "schedule" as used in Provision 52.214-0019, CONTRACT AWARD--SEALED BIDDING--CONSTRUCTION, in Section 00100 INSTRUCTIONS, CONDITIONS, AND NOTICES TO BIDDERS.

7. EXERCISE OF OPTIONS (SWDR 715-1-1 (16 January 1996))

The Government reserves the right to exercise the option(s) by written notice to the Contractor either singularly or in any combination for up to **90** calendar days after award of the Base Bid without an increase in the Offeror's Bid Price. Completion of added items shall continue at the same schedule as the Base Bid unless otherwise noted in Section 01000 CONSTRUCTION SCHEDULE, paragraph 1 entitled SCHEDULE. NOTES cont.

8. ABBREVIATIONS

For the purpose of this solicitation, the units of measure are represented as follows:

a. LS (lump sum)
b. MM (millimeters)
c. LM (length in linear meters)
d. EA (each)
e. CM (cubic meter)
f. SM (square meter)

**END OF BIDDING SCHEDULE**

# SECTION 01000

## CONSTRUCTION SCHEDULE
**06/2002**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 SCHEDULE

Commence, prosecute, and complete the work under this contract in accordance with the following schedule and Section 00700 CONTRACT CLAUSES COMMENCEMENT, PROSECUTION AND COMPLETION OF WORK and LIQUIDATED DAMAGES:

| Item of Work | Commencement of Work (calendar days) | Completion of Work (calendar days) | Liquidated Damages per calendar day |
|---|---|---|---|
| (1) All Work except Establishment of Turf and Landscaping | Within 10 days after receipt of Notice to Proceed | 458 | $ 1,860 |
| (2) Establishment of Turf | * | * | --- |
| (3) Landscaping | ** | ** | --- |

*Establishment of Turf

Planting and maintenance for turfing shall be in accordance with Section 02925 ESTABLISHMENT OF TURF . No payment will be made for establishment of turf until all requirements of the section are adequately performed and accepted, as determined by the Contracting Officer.

**Landscaping

Planting and maintenance for landscaping shall be in accordance with Section 02931 PLANTING OF TREES, SHRUBS, AND VINES and Sections 02935 EXTERIOR PLANT MATERIAL MAINTENANCE. No payment will be made for landscaping until all requirements of the section are adequately performed and accepted, as determined by the Contracting Officer.

#### 1.1.1 Testing of Heating and Air-Conditioning Systems

The times stated for completion of this project includes all required testing specified in appropriate specification sections of heating, air conditioning and ventilation systems including HVAC Commissioning. Exception: boiler combustion efficiency test, boiler full load tests, cooling tower performance tests, and refrigeration equipment full load tests, when specified in the applicable specifications, shall be preformed in the appropriate heating/cooling season as determined by the Contracting Officer.

1.2 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER (OCT 1989) (ER 415-1-15)(52.0001-4038 1/96)

a. This provision specifies the procedure for determination of time extensions for unusually severe weather in accordance with the contract clause entitled "Default: (Fixed Price Construction)." In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

(1) The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.

(2) The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the contractor.

b. The following schedule of monthly anticipated adverse weather delays due to precipitation and temperature is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities. Wind is not considered in the Monthly Anticipated Adverse Weather Calendar Day Schedule.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY
WORK DAYS BASED ON (5) DAY WORK WEEK

ABILENE, TX AREA (DYESS AFB AND RESERVE CTRS. WITHIN 80 MILE RADIUS, EXCEPT WITHIN 40 MILES OF SAN ANGELO,TX.)

| JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 2 | 2 | 4 | 3 | 3 | 2 | 3 | 3 | 1 | 2 |

c. Upon acknowledgment of the Notice to Proceed (NTP) and continuing throughout the contract, the contractor will record on the daily CQC report, the occurrence of adverse weather and resultant impact to normally scheduled work. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the contractor's scheduled work day.

The number of actual adverse weather delay days shall include days impacted by actual adverse weather (even if adverse weather occurred in previous month), be calculated chronologically from the first to the last day of each month, and be recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in paragraph "b", above, the Contracting Officer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair weather work days, and issue a modification in accordance with the contract clause entitled "Default (Fixed Price Construction)."

1.3 **(AM#1) CONSTRUCTION PHASING**

**See the drawings for phasing requirements.**

## 1.4 WORK RESTRICTIONS

### 1.4.1 Working Hours

Normal working hours are as specified in SECTION 01363 SPECIAL PROJECT PROCEDURES FOR DYESS AIR FORCE BASE.

### 1.4.2 Security Requirements

For the duration of this Contract, access to the Installation may be delayed between 30 minutes to an hour or more due to security precautions, including the checking of vehicle occupants' IDs, vehicle manifests, and the searching of all vehicles. Any general or specific threat to the safety of those working or living at Dyess AFB could result in longer waiting times at the access points to Dyess AFB.

## 1.5 UTILITIES

### 1.5.1 Payment for Utility Services

In accordance with Contract Clause 52.236.14 AVAILABILITY AND USE OF UTILITY SERVICES, water, gas, and electricity are available from Government-owned and operated systems and will be furnished without charge to the Contractor as specified in Section 01363 SPECIAL PROJECT PROCEDURES FOR DYESS AIR FORCE BASE.

### 1.5.2 Outages

In addition to the requirements specified in Section 01363 SPECIAL PROJECT PROCEDURES FOR DYESS AIR FORCE BASE, the Contractor shall coordinate all requests for utility outages with the Contracting Officer in writing 14 days prior to date of requested outage:

a. Water, gas, steam, and sewer outages shall be held to a maximum duration of 4 hours unless otherwise approved in writing.

b. Electrical outages shall have a maximum duration of 4 hours.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION (NOT USED)

-- End of Section --

# SECTION 01330

# SUBMITTAL PROCEDURES
**03/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 SUBMITTAL IDENTIFICATION (SD)

Submittals required are identified by SD numbers and titles as follows:

SD-01 Preconstruction Submittals

Certificates of insurance.
Surety bonds.
List of proposed subcontractors.
List of proposed products.
Construction Progress Schedule.
Submittal schedule.
Schedule of values.
Health and safety plan.
Work plan.
Quality control plan.
Environmental protection plan.

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the contractor for integrating the product or system into the project.

Drawings prepared by or for the contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

Calculations, mix designs, analyses or other data pertaining to a part of work.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes findings of a test required to be performed by the contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports

Daily checklists

Final acceptance test and operational test procedure

SD-07 Certificates

Statements signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a supplier, installer or subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

Factory test reports.

SD-10 Operation and Maintenance Data

Data intended to be incorporated in operations and maintenance manuals.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Record (e.g. As-built) drawings.

Special warranties.

Posted operating instructions.

Training plan.

## 1.2 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

### 1.2.1 Government Approved

Government approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

### 1.2.2 Information Only

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

## 1.3 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

## 1.4 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Contracting Officer.

## 1.5 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

## 1.6 GENERAL

The Contractor shall make submittals as required by the specifications or by individual task orders. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) System Manager and each item shall be stamped, signed, and dated by the CQC System Manager indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

## 1.7 SUBMITTAL REGISTER

At the end of this section is a submittal register showing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional submittals may be required. The Contractor will also be given the initial submittal register files, containing the computerized ENG Form 4288 and instructions on the use of the files. These submittal register files will be furnished on the Award CD-ROM disk. The Contractor shall complete the ENG Form 4288, columns "a" and "s" through "u", and submit the forms (hard copy plus associated electronic file) to the Contracting Officer for approval within 21 calendar days after Notice to Proceed. The Contractor shall keep the submittal register files up-to-date and shall submit them to the Government together with the monthly payment request. The approved submittal register will become the scheduling document and will be used to control submittals throughout the life of the Contract. The submittal register and the progress schedules shall be coordinated.

## 1.8 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 60 calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals. An additional 7 calendar days shall be allowed and shown on the register for review and approval of submittals for **(AM#1) food service equipment and** refrigeration and HVAC control systems.

1.9 TRANSMITTAL FORM (ENG FORM 4025)

The sample transmittal form (ENG Form 4025) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. These forms will be furnished to the Contractor. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care shall be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item. If the item, product, or system has previously been approved for another task order for use under the same conditions, indicate the task order number and approval date on the ENG Form 4025.

1.10 SUBMITTAL PROCEDURES

Submittals shall be made as follows:

1.10.1 Procedures

1.10.1.1 Additional Instructions

In addition to the requirements of this Section, additional instructions are specified in the attachment "INSTRUCTIONS TO CONTRACTORS FOR TRANSMITTAL REQUIRMENTS" located at the end of this section.

1.10.1.2 Contractor Review

The Contractor's quality control representative shall review the listing at least every 30 days and take appropriate action to maintain an effective and updated system. A copy of the register or progress schedule shall be maintained at the job site. Revised and/or updated register or progress schedule shall be submitted to the Contracting Officer at least every 60 days in quadruplicate (complete register need not be provided, only those portions containing additions or changes).

1.10.1.3 Number of Copies

The Contractor shall provide **(AM#1) five (5)** sets of all submittals.

1.10.1.4 Address to Receive Submittals

**(AM#1) Four (4) submittals** shall be sent to the Corps of Engineers' Area Office assigned to the project **(AM#1) and one (1) to the local Project Office**.

1.10.1.5 Additional Government Approved Submittals

In addition to those specified in PART 1 paragraph SUBMITTAL CLASSIFICATION, the following classifications of submittals also require Governmental approval:

a. Mechanical and Electrical Systems

The Contractor shall furnish one reproducible, unfolded copy of all wiring and control diagrams and approved system layout drawings with the operating instructions called for under the various headings of the specifications for mechanical and electrical systems.

b. Fire Protection and Detection Submittals

The Contractor shall prepare and submit, as one integrated submittal, shop drawings for the fire protection/detection system. This submittal shall also include sprinkler plans and sections, fire detection and alarm plans and risers, and catalog cuts of proposed equipment. The Contractor shall submit proof that the shop drawings were prepared by an engineer regularly engaged in fire protection/detection systems for at least 2 years, and that they are sealed by a registered professional engineer. Shop drawings for the fire protection/detection system shall be prepared on full-size reproducible sheets. The shop drawings submitted for review shall be submitted on full-size prints. After updating all deviations, modifications, and changes, the final submittal shall be on reproducible sheets and CADD files (submitted on CD-ROM disk(s)); these will represent the final as-built drawings.

c. Asbestos and lead-based paint abatement submittals.

d. Color/finish sample boards submittal.

1.10.1.6 Certificates of Compliance

Any certificates required for demonstrating proof of compliance of materials with specification requirements shall be executed in the number of copies required by the above paragraph "Number of Copies." Each certificate shall be signed by an official authorized to certify in behalf of the manufacturing company and shall contain the name and address of the Contractor, the project name and location, and the quantity and date or dates of shipment or delivery to which the certificates apply. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the tests to which the report applies. Certification shall not be construed as relieving the Contractor from furnishing satisfactory material, if, after tests are performed on selected samples, the material is found not to meet the specific requirements.

1.10.2 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

1.11 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

1.12 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. One (1) copy of the submittal will be returned to the Contractor. The remainder will be retained by the Government.

## 1.13 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

## 1.14 PREVIOUSLY APPROVED SUBMITTALS

Complete submittals other than an ENG Form 4025 need not be submitted for items, products, or systems that have previously been approved and are on file at the Corps of Engineers' Area. See paragraph TRANSMITTAL FORM (ENG FORM 4025).

## 1.15 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

| CONTRACTOR |
|---|
| (Firm Name) |
| _____ Approved |
| _____ Approved with corrections as noted on submittal data and/or attached sheets(s). |
| SIGNATURE: ____________________ |
| TITLE: ____________________ |
| DATE: ____________________ |

1.16 INSTRUCTIONS TO CONTRACTORS FOR TRANSMITTAL REQUIREMENTS

FORT WORTH DISTRICT

FOR INFORMATION ONLY (FIO) AND GOVERNMENT APPROVED (G) SUBMITTALS

1. General Requirements

a. General requirements for transmittal of FIO and G submittals is contained in the preceding specifications. Specific requirements on how to transmit FIO and G Submittals are outlined herein.

b. FIO and G submittal data shall be transmitted under separate ENG Form 4025s and assigned different Transmittal Numbers. If G and FIO submittal data is included in the same submittal, using the same ENG Form 4025, they will be considered an FIO submittal until the Contractor corrects the error.

c. The Contractor shall designate on each Eng Form 4025, above the Transmittal No., either FIO or G to show the transmittal type. This procedure allows ready identification of FIO or G submittals. The Government reserves the right to redesignate the category (G or FIO) of submittals incorrectly identified by the Contractor.

d. The Contractor shall assure all FIO submittals for each technical section are submitted prior to or concurrent with the G submittals for that technical section. If appropriate FIO submittals have not been submitted, the G submittal will be returned disapproved.

e. Data transmitted with ENG Form 4025 shall be identified by marking it with the same item number(s) appearing in the "Item No." column on the form. The model number, part number, color, etc., of proposed materials or equipment shall be highlighted or otherwise identified.

f. The Contractor shall identify and include with each submittal a copy of any modification and/or Request for Information (RFI) or Government Correspondence that may have changed the requirments of the Contract in regards to each individual submittal.

2. Specific Requirements for For Information Only (FIO) Submittals

a. One fully coordinated FIO submittal shall be made for each technical section. Each FIO submittal listed on the ENG Form 4288, shall be submitted as a separate item on the ENG Form 4025 in the order they appear on the progress schedule. Technical data provided with the ENG Form 4025 shall conform to the "Submittals" paragraph in each Technical Section. (Example: SD-02 Shop Drawings as outlined herein.)

b. Items such as mill certificates or other test data unavailable until the equipment/material is manufactured/fabricated shall be identified on the initial ENG Form 4025. An explanation in the "Remarks" section shall explain this data will be submitted by Transmittal Number [ ] (fill in transmittal number) after materials are manufactured/fabricated (or other explanations as appropriate). A separate submittal for long lead time equipment or material may be made if sufficient data is furnished to show contract compliance. An explanation shall be provided in the "Remarks" section or on a separate sheet, if necessary, explaining why a partial submittal is being made. Explanation shall include the estimated delivery date of the above equipment/material and the Transmittal Number of the submittal that will contain data required by the particular specification section for the remaining equipment/materials. For contracts with several buildings/structures, separate transmittals for each technical section may be used if each building/structure is noted in the "Remarks" section of the ENG Form 4025. Samples of materials shall be submitted along with technical data, not under separate transmittals.

2.1 FIO Submittal Review

a. The Contractor's Quality Control (CQC) Representative has full responsibility for reviewing and certifying that all FIO submittal data and all equipment and/or materials comply with the contract. FIO Submittals are provided to the Government "For Information Purposes Only." Contracting Officer approval is not required and will not be given. The Government will not code any FIO submittals. Copies of FIO Submittals will not be returned to the Contractor.

b. However, the Government may perform QA reviews and re-reviews of FIO submittals at any time during the contract. If the Government determines submittal data is incomplete or not in compliance with contract, comments will be provided. Comments will state, "Disagree with Contractor's Certified Compliance" and list items not in compliance or not provided as required by the Contract. The Contractor shall respond to all comments by return FIO resubmittal on a new ENG Form 4025. Repeated incomplete or non-complying FIO submittals with improper certifications may result in disapproval of the Contractor's Quality Control (CQC) Program and/or possible replacement of the Contractor Quality Control (CQC) personnel.

c. Performance of, or failure to perform QA submittal reviews or Government requirement to submit additional data on FIO submittals, will not prevent the Contracting Officer from requiring removal and replacement of non-conforming material incorporated into the work. No adjustment for time or money will be allowed for corrections required because of non-compliance with contract plans and/or specifications.

3. Specific Requirements for Government (G) Approved Submittals

a. The Contractor's Quality Control Representative is responsible for assuring all data submitted is complete and in compliance with contract requirements. The Contractor shall assure all FIO submittals are submitted prior to or concurrent with the G submittal for each technical section. If the FIO submittals have not been submitted, the G submittal will be returned disapproved.

b. A separate submittal shall be made for each technical section with G submittals. FIO submittal data shall not be mixed with G submittal data.

c. The Government will provide written comments as appropriate and assign action codes to each item outlined on the back of the ENG Form 4025. One (1) stamped and dated copy of the submittal, along with any comments, will be provided to the Contractor. Action Code "A"- Approved As Submitted, and Code "B"- Approved Except As Noted, constitutes Government Approval. The Contractor shall resubmit under a separate Transmittal Number all data necessary to show compliance with Government comments on all other action codes.

d. Government review time, as stated in Paragraph 3.3 - Scheduling, is a minimum of sixty (60) calendar days unless otherwise specified. Government review time is exclusive of mailing time. Review time starts the day of receipt by the Government and continues until the day comments or notice of approval is provided the Contractor.

e. If the Contractor considers any Government review comment to constitute a change to the contract, notice shall be given promptly as required under the Contract Clause entitled "Changes." No request for "Equitable Adjustment" will be honored unless the Contractor complies fully with the prompt notice provisions of the contract.

4. Variations/Deviations/Departures from the Contract Drawings or Specifications

Contractor proposed variations, deviations, or departures from the contract drawings or specifications shall be noted in the "Variation" column of ENG Form 4025 with an asterisk, for each FIO submittal. A brief explanation, and the Transmittal Number of the appropriate "G" submittal (as explained below), shall be added to the "Remarks" section of the Form (or a separate sheet, if necessary). Each variation, deviation, or departure shall be listed as an item on a separate "G" submittal, which may contain other G submittal items. Variations, deviations, or departures will be processed and approved the same as G submittals, provided they are included in a G submittal. Variations, deviations, or departures will not be approved in the FIO submittal, and will be disapproved, until they are properly submitted on a "G" submittal. Variations, deviations, or departures shall contain sufficient information to permit complete evaluation. Additional sheets may be used to fully explain why a variation, deviation, or departure is requested. The Government reserves the right to disapprove or rescind inadvertent approval of submittals containing unnoted variations, deviations, or departures.

5. Submittal Numbering

Each submittal shall cover only one specification section. For purposes of consistency and to provide compatibility with the Government's computerized submittal register, submittal numbers shall include a specification section prefix and special suffixes. Note the following examples (for Technical Section 07416):

a. New submittals - 07416-01, 07416-02, etc.

b. Resubmittals -

(1) First resubmittal - 07416-01.01, 07416-02.01, etc.

(2) Second resubmittal - 07416-01.02, 07416-02.02, etc.

(3) Third resubmittal - 07416-01.03, 07416-02.03, etc.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

-- End of Section --

# SECTION 02220

# DEMOLITION

**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual |

### 1.2 GENERAL REQUIREMENTS

The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Rubbish and debris shall be removed from Government property daily, unless otherwise directed, to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer. In the interest of occupational safety and health, the work shall be performed in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections. In the interest of conservation, salvage shall be pursued to the maximum extent possible (in accordance with Section 01572 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT, if applicable); salvaged items and materials shall be disposed of as specified.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Work Plan; G.

The procedures proposed for the accomplishment of the work. The procedures shall provide for safe conduct of the work, including procedures and methods to provide necessary supports, lateral bracing and shoring when required, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The procedures shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in accordance with EM 385-1-1.

## 1.4 DUST CONTROL

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding and pollution.

## 1.5 PROTECTION

### 1.5.1 Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

### 1.5.2 Protection of Structures

Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, shall remain standing without additional bracing, shoring, of lateral support until demolished, unless directed otherwise by the Contracting Officer. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

### 1.5.3 Protection of Existing Property

Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

### 1.5.4 Protection From the Weather

The interior of buildings to remain; salvageable materials and equipment shall be protected from the weather at all times.

#### 1.5.5 Protection of Trees

Trees within the project site which might be damaged during demolition, and which are indicated to be left in place, shall be protected by a 1.8 m (6 foot) high fence. The fence shall be securely erected following the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the work under this contract shall be replaced in kind or as approved by the Contracting Officer.

#### 1.5.6 Environmental Protection

The work shall comply with the requirements of Section 01355 ENVIRONMENTAL PROTECTION.

### 1.6 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

### 1.7 USE OF EXPLOSIVES

Use of explosives will not be permitted.

### 1.8 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available in accordance with the following schedule:

| Area | Date |
|---|---|
| [AM#1] ____________ | [AM#1] _____________ |
| [AM#1] New Tower Parking Area | [AM#1] Upon Notice to Proceed |
| [AM#1] Buildings 4215 and 4301 | [AM#1] 9 September 2002 |
| [AM#1] Building 4302 | [AM#1] 1 February 2003 |
| [AM#1] Building 4214 | [AM#1] 1 March 2003 |

## PART 2 PRODUCTS (Not Applicable)

## PART 3 EXECUTION

### 3.1 EXISTING STRUCTURES

Existing structures indicated shall be removed to 2 meters below grade. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

### 3.2 UTILITIES

Existing utilities shall be removed as indicated. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area.

## 3.3 FILLING

Holes, open basements and other hazardous openings shall be filled in accordance with Section 02300 EARTHWORK.

## 3.4 DISPOSITION OF MATERIAL

Title to material and equipment to be demolished, except Government salvage items, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

### 3.4.1 Salvageable Items and Material

Contractor shall salvage items and material to the maximum extent possible.

#### 3.4.1.1 Material Salvaged for the Contractor

Material salvaged for the Contractor shall be stored as approved by the Contracting Officer and shall be removed from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

#### 3.4.1.2 Items Salvaged for the Government

Salvaged items to remain the property of the Government shall be removed in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage shall be repaired or replaced to match existing items. Containers shall be properly identified as to contents. Items reserved as property of the Government as shown on the plans shall be delivered to the areas designated: by the Contracting Officer.

### 3.4.2 Unsalvageable Material

Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of in the disposal area located off the site. Combustible material shall be disposed of off the site.

## 3.5 CLEAN UP

Debris and rubbish shall be removed from basement and similar excavations. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

## 3.6 PAVEMENTS

Existing pavements designated for removal shall be saw cut and removed in accordance with the details shown on the drawings and to the limits and depths indicated on the drawings.

-- End of Section --

# SECTION 02315

# EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS
**08/98**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM D 1556 | (1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 1557 | (1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.)) |
| ASTM D 2216 | (1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock |
| ASTM D 2487 | (2000) Classification of Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D 2922 | (1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 2937 | (1994) Density of Soil in Place by the Drive-Cylinder Method |
| ASTM D 3017 | (1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 4318 | (2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils |

### 1.2 DEGREE OF COMPACTION

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, Method C, abbreviated as percent laboratory maximum density.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Testing.

Copies of all laboratory and field test reports within 24 hours of the completion of the test. {AM#0001}One copy shall be sent to both the Local Project and Area Office.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM,SC, CL, CH and shall be free of trash, debris, roots, or other matter, or stones larger than 76 mm in any dimension.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include materials classified in ASTM D 2487 as Pt, OH, OL, ML, MH and man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 76mm. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Nonexpansive Soils

Non expansive soils shall meet the requirements of Texas Department of Transportation Standard specification for base course, Item 247, Type A, Grade 1 or 2.

2.1.4 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM shall be identified as cohesionless only when the fines are nonplastic.

2.1.5 Select Soils

Select soils shall be any satisfactory material having a liquid limit of 35% or less and a plasticity index of not less than 4 nor greater than 18 when tested in accordance with ASTM D 4318.

## 2.2 CAPILLARY WATER BARRIER

Capillary Water Barrier shall consist of clean, crushed, nonporous rock, crushed gravel, or uncrushed gravel. The maximum particle size shall be 37.5 mm and no more than 2 percent by weight shall pass the 4.75 mm (No. 4) size sieve.

# PART 3 EXECUTION

## 3.1 CLEARING AND GRUBBING

Clearing and grubbing is specified in Section 02230 CLEARING AND GRUBBING.

## 3.2 TOPSOIL

Topsoil shall be stripped to a depth of 150 millimeters below existing grade within the designated excavations and grading lines and deposited in storage piles for later use. Excess topsoil shall be disposed as specified for excess excavated material.

## 3.3 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each building, structure, and footing except as specified, and shall include trenching for utility and foundation drainage systems to a point 1.5 m beyond the building line of each building and structure, excavation for all work incidental thereof. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed and replaced with satisfactory material; and payment will be made in conformance with the CHANGES clause of the CONTRACT CLAUSES. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced, at no additional cost to the Government, with satisfactory materials to the indicated excavation grade; except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations and over-break in rock excavation. Satisfactory material shall be placed and compacted as specified in paragraph FILLING AND BACKFILLING. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

## 3.4 DRAINAGE AND DEWATERING

### 3.4.1 Drainage

Surface water shall be directed away from excavation and construction sites to prevent erosion and undermining of foundations. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

#### 3.4.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 900 mm of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 0.6meters below the working level.

### 3.5 SHORING

Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving.

### 3.6 CLASSIFICATION OF EXCAVATION

Excavation will be unclassified regardless of the nature of material encountered.

### 3.7 BLASTING

Blasting will not be permitted.

### 3.8 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 150 mm below the bottom of the pipe, and the overdepth shall be backfilled with satisfactory material placed and compacted in conformance with paragraph FILLING AND BACKFILLING.

### 3.9 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved materials shall be obtained as specified in Section 02300 EARTHWORK. Nonexpansive soils for nonexpansive fill shall be obtained from approved private sources selected by the Contractor.

### 3.10 EXCAVATED MATERIALS

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Section 02300 EARTHWORK.

## 3.11 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Excavation to final grade shall not be made until just before concrete is to be placed. Only excavation methods that will leave the foundation rock in a solid and unshattered condition shall be used. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut as indicated into rough steps or benches to provide a satisfactory bond. Shales shall be protected from slaking and all surfaces shall be protected from erosion resulting from ponding or flow of water.

## 3.12 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. Remove a minimum of 1.5 meters of existing foundations and all surrounding materials and replace with compacted nonexpansive backfill material within the limits of the building pad. The existing subgrade exposed after excavation operations shall be scarified to a depth of 150 mm before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 150 mm, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 300 mm and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING.

## 3.13 FILLING AND BACKFILLING

Satisfactory materials shall be used in bringing fills and backfills to the lines and grades indicated and for replacing unsatisfactory materials. Nonexpansive and select soils shall be used in fill under building floor slabs and foundation. All fill required to raise the subgrade to the final elevation(s) below structurally-supported floor slabs should be select material. Removal and replacement of existing material with nonexpansive or select material shall be as specified in paragraph SUBGRADE PREPARATION. All fill required to raise the subgrade to the final elevation(s) below floor slabs on grade shall be nonexpansive material. Satisfactory materials shall be placed in horizontal layers not exceeding 200 mm in loose thickness, or 150 mm when hand-operated compactors are used. After placing, each layer shall be plowed, disked, or otherwise broken up, moistened or aerated as necessary, thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade . Backfill shall not be placed in wet or frozen areas. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 600 mm above sewer lines and 300 mm above other utility lines shall be free from stones larger than 25 mm in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 100 mm in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall. Each layer of fill and backfill shall be compacted to not less than the percentage of maximum density specified below:

| | Percent Laboratory maximum density | |
|---|---|---|
| | Cohesive material | Cohesionless material |
| Fill, embankment, and backfill | | |
| Under structures, building slabs, steps, paved areas, around footings, and in trenches | 90 | 95 |
| Under sidewalks and grassed areas | 85 | 90 |
| NonExpansive materials | Compacted to not less than 92 percent | |
| Select Materials | | Not less than 90 |
| Subgrade | | |
| Under building slabs, steps, and paved areas, top 300 mm | 90 | 95 |
| Under sidewalks, top 150 mm | 85 | 90 |

| | Percent Laboratory maximum density | |
|---|---|---|
| | Cohesive material | Cohesionless material |
| Under nonexpansive fill top 150 mm | Compacted to not less than 92% | |
| Under select fill top 150 mm | Compacted to not less than 90% | |

Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and compacted as specified herein before to the required density prior to further construction thereon. Recompaction over underground utilities and heating lines shall be by hand tamping.

## 3.14 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D 2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D 2937 shall be used only for soft, fine-grained, cohesive soils. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation. All technicians testing for density shall be NICET Level I certified.

### 3.14.1 In-Place Densities

In-place density and moisture content test results shall be included with the Contractor's daily construction quality control reports.

#### 3.14.1.1 In-Place Density of Subgrades

One test per 100 square meters or fraction thereof.

#### 3.14.1.2 In-Place Density of Fills and Backfills

One test per 100 square meters or fraction thereof of each lift for fill or backfill areas compacted by other than hand or hand-operated machines. The density for each lift of fill or backfill materials for trenches, pits, building perimeters or other structures or areas less than 152 meters in width, which are compacted with hand or hand-operated machines shall be tested as follows: One test per each area less than 46 square meters, or one test for each 30 linear meter of long narrow fills 91 meters or more in length. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 as follows: One check per lift for each 91 linear meters of long narrow fills, and a minimum of 1 check per 500 sq. meters.

3.14.2 Moisture Content

In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D 2216.

3.14.3 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material, including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 385 cubic meters of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density will be made.

3.15 CAPILLARY WATER BARRIER

Capillary water barrier under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.16 GRADING

Areas within 1.5 m outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

3.17 SPREADING TOPSOIL

Areas outside the building lines from which topsoil has been removed shall be topsoiled. The surface shall be free of materials that would hinder planting or maintenance operations. The subgrade shall be pulverized to a depth of 50 mm by disking or plowing for the bonding of topsoil with the subsoil. Topsoil shall then be uniformly spread, graded, and compacted to the thickness, elevations, slopes shown, and left free of surface irregularities. Topsoil shall be compacted by one pass of a cultipacker, roller, or other approved equipment weighing 1.46 kN/m to 2.34 kN/m of roller. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading.

3.18 PROTECTION

Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work, shall be repaired and grades reestablished to the required elevations and slopes.

-- End of Section --

# SECTION 02510

# WATER DISTRIBUTION SYSTEM

**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 53 | (1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM B 88M | (1996) Seamless Copper Water Tube (Metric) |
| ASTM D 1599 | (1999) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings |
| ASTM D 1784 | (1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D 1785 | (1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D 2241 | (1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) |
| ASTM D 2464 | (1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D 2466 | (1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM D 2467 | (1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D 2564 | (1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D 2657 | (1997) Heat Fusion Joining Polyolefin Pipe and Fittings |
| ASTM D 2774 | (1994) Underground Installation of |

| | |
|---|---|
| | Thermoplastic Pressure Piping |
| ASTM D 2855 | (1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings |
| ASTM D 2996 | (1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe |
| ASTM D 2997 | (1995) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe |
| ASTM D 3139 | (1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals |
| ASTM D 3839 | (1994a) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe |
| ASTM D 4161 | (1996) "Fiberglass"(Glass-Fiber-Reinforced Thermosetting Resin) Pipe Joints Using Elastomeric Seals |
| ASTM F 477 | (1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F 1483 | (1998) Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.3 | (1992) Malleable Iron Threaded Fittings |
| ASME B16.26 | (1988) Cast Copper Alloy Fittings for Flared Copper Tubes |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA B300 | (1992) Hypochlorites |
| AWWA B301 | (1992) Liquid Chlorine |
| AWWA C104 | (1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water |
| AWWA C110 | (1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids |

| | |
|---|---|
| AWWA C111 | (1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C115 | (1996) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges |
| AWWA C151 | (1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids |
| AWWA C153 | (1994; Errata Nov 1996) Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm through 610 mm) and 54 In. through 64 In. (1,400 mm through 1,600 mm) for Water Service |
| AWWA C203 | (1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied |
| AWWA C205 | (1995) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied |
| AWWA C207 | (1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm) |
| AWWA C300 | (1997) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids |
| AWWA C301 | (1992) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids |
| AWWA C303 | (1995) Concrete Pressure Pipe, Bar-Wrapped, Steel Cylinder Type |
| AWWA C500 | (1993; C500a) Metal-Sealed Gate Valves for Water Supply Service |
| AWWA C502 | (1994; C502a) Dry-Barrel Fire Hydrants |
| AWWA C600 | (1993) Installation of Ductile-Iron Water Mains and Their Appurtenances |
| AWWA C606 | (1997) Grooved and Shouldered Joints |
| AWWA C700 | (1995) Cold-Water Meters - Displacement Type, Bronze Main Case |
| AWWA C800 | (1989) Underground Service Line Valves and Fittings |

| | |
|---|---|
| AWWA C900 | (1997; C900a) Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution |
| AWWA C901 | (1996) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service |
| AWWA C950 | (1995) Fiberglass Pressure Pipe |
| AWWA M16 | (1978) Work Practices for Asbestos Cement Pipe |
| AWWA M23 | (1980) Manual: PVC Pipe - Design and Installation |

ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)

| | |
|---|---|
| ACPPA Work Practices | (1988) Recommended Work Practices for A/C Pipe |

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

| | |
|---|---|
| DIPRA-Restraint Design | (1997) Thrust Restraint Design for Ductile Iron Pipe |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 24 | (1995) Installation of Private Fire Service Mains and Their Appurtenances |
| NFPA 49 | (1994) Hazardous Chemicals Data |
| NFPA 325-1 | (1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids |
| NFPA 704 | (1996) Identification of the Fire Hazards of Materials for Emergency Response |

NSF INTERNATIONAL (NSF)

| | |
|---|---|
| NSF 14 | (1998) Plastics Piping Components and Related Materials |
| NSF 61 | (1999) Drinking Water System Components - Health Effects (Sections 1-9) |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 21 | (1991) White or Colored Silicone Alkyd Paint |

| | |
|---|---|
| SSPC Paint 25 | (1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments) |

## 1.2 PIPING

This section covers water supply, distribution, and service lines, and connections to building service at a point approximately 1.5 m outside buildings and structures to which service is required. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure to be utilized available at the construction site at all times.

### 1.2.1 Service Lines

Piping for water service lines less than 80 mm (3 inches) in diameter shall be galvanized steel, polyvinyl chloride (PVC) plastic, Oriented PVC plastic polyethylene, or copper tubing, unless otherwise shown or specified. Piping for water service lines 80 mm (3 inches) and larger shall be ductile iron, polyvinyl chloride (PVC) plastic, filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe or steel, unless otherwise shown or specified.

### 1.2.2 Distribution Lines 80 mm (3 Inches) or Larger

Piping for water distribution lines 80 mm (3 inches) or larger shall be ductile iron, polyvinyl chloride (PVC) through 900 mm (36 inch) nominal diameter plastic, Oriented PVC plastic filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, or reinforced concrete, unless otherwise shown or specified.

### 1.2.3 Supply Lines 80 mm (3 Inches) or Larger

Piping for water supply lines 80 mm (3 inches) or larger shall be ductile iron, polyvinyl chloride (PVC) plastic, through 900 mm (36 inch) nominal diameter, Oriented PVC plastic filament-wound reinforced or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, steel, or reinforced concrete, unless otherwise shown or specified.

### 1.2.4 Sprinkler Supply Lines

Piping for water lines supplying sprinkler systems for building fire protection shall conform to NFPA 24 from the point of connection with the water distribution system to the building 1.5 m line.

### 1.2.5 Potable Water Lines

Piping and components of potable water systems which come in contact with the potable water shall conform to NSF 61.

### 1.2.6 Plastic Piping System

Plastic piping system components (PVC, polyethylene, thermosetting resin and reinforced plastic mortar pressure) intended for transportation of potable water shall comply with NSF 14 and be legibly marked with their symbol.

#### 1.2.7 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

### 1.3 MANUFACTURER'S REPRESENTATIVE

The Contractor shall have a manufacturer's field representative present at the jobsite during the installation and testing of PE, RTRP, and/or RPMP pipe to provide technical assistance and to verify that the materials are being installed in accordance with the manufacturer's prescribed procedures. When the representative feels that the Contractor is installing and testing the PE, RTRP, and/or RPMP pipe in a satisfactory manner, certification shall be written to note which individuals employed by the Contractor are capable of properly installing the pipe. The field representative shall advise the Contractor of unsatisfactory conditions immediately when they occur. Such conditions include improper diameter of pipe ends, damaged interior liner, poorly prepared joints, improper curing of joints, moving pipe before joints are cured, bending pipe to follow abrupt changes in trench contours, leaving pipe ends open in trench overnight, not properly drying joints after rain storms, exceeding effective adhesive life, sharp objects in trench bed, backfill that could damage pipe, improper procedure for concrete encasement of pipe, omission of thrust blocks at changes in direction or any other condition which could have an adverse effect on the satisfactory completion and operation of the piping system.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Installation.

The manufacturer's recommendations for each material or procedure to be utilized.

Waste Water Disposal Method.

The method proposed for disposal of waste water from hydrostatic tests and disinfection, prior to performing hydrostatic tests.

Satisfactory Installation.

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications, and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

SD-06 Test Reports

Bacteriological Disinfection.

Test results from commercial laboratory verifying disinfection.

SD-07 Certificates

Manufacturer's Representative.

The name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified in all phases of PE, RTRP, and/or RPMP pipe laying and jointing and experienced to supervise the work and train the Contractor's field installers, prior to commencing installation.

Installation.

A statement signed by the manufacturer's field representative certifying that the Contractor's personnel are capable of properly installing the pipe on the project.

Meters.

Manufacturer's certificate stating that each meter furnished has been tested for accuracy of registration and compliance with the accuracy and capacity requirements of the appropriate AWWA standard.

## 1.5 HANDLING

Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Government. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

### 1.5.1 Coated and Wrapped Steel Pipe

Coated and wrapped steel pipe shall be handled in conformance with AWWA C203.

1.5.2 Polyethylene (PE) Pipe Fittings and Accessories

PE pipe, fittings, and accessories shall be handled in conformance with AWWA C901.

1.5.3 Miscellaneous Plastic Pipe and Fittings

Polyvinyl Chloride (PVC), Reinforced Thermosetting Resin Pipe (RTRP), and Reinforced Plastic Mortar Pressure (RPMP) pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

PART 2 PRODUCTS

2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Reinforced and Prestressed Concrete Pipe

Steel cylinder reinforced concrete pipe shall conform to AWWA C300, AWWA C301, or AWWA C303 and shall be designed to withstand a working pressure of not less than 1.03 MPa (150 psi) unless otherwise shown or specified.

2.1.2 Plastic Pipe

2.1.2.1 PE Plastic Pipe

Pipe, tubing, and heat-fusion fittings shall conform to AWWA C901.

2.1.2.2 PVC Plastic Pipe

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454B.

a. Pipe Less Than 100 mm (4 inch) Diameter:

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 1.03 MPa (150 psi) working pressure, 1.38 MPa (200 psi) hydrostatic test pressure, unless otherwise shown or specified. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Elastomeric-Gasket Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 40, with joints meeting the requirements of 1.03 MPa (150 psi) working pressure, 1.38 MPa (200 psi) hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D

2241, elastomeric joint, with the following applications:

| SDR | Maximum Working Pressure MPa | Minimum Hydrostatic Pressure MPa |
|---|---|---|
| 26 | 0.689 | 0.917 |
| 21 | 0.827 | 1.103 |
| 17 | 1.034 | 1.379 |
| 13.5 | 1.379 | 1.834 |

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa (150 psi) working pressure and 1.38 MPa (200 psi) hydrostatic test pressure.

b. Pipe 100 through 300 mm Diameter: Pipe, couplings and fittings shall conform to AWWA C900, Class 150, CIOD pipe dimensions, elastomeric-gasket joint, unless otherwise shown or specified.

2.1.2.3 Oriented Polyvinyl Chloride (PVCO) Plastic Pipe

Pipe, couplings, and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454-B. Pipe shall conform to AWWA C909, Class 150, and to ASTM F 1483 and shall have an outside diameter equal to cast iron outside diameter.

2.1.3 Reinforced Plastic Mortar Pressure (RPMP) Pipe

RPMP shall be produced by centrifugal casting and shall have an OD 304 to 1219 mm equal to ductile-iron, with a 1034 kPa pressure rating and with a minimum pipe stiffness of 248 kPa. RPMP shall be in accordance with AWWA C950.

2.1.4 Reinforced Thermosetting Resin Pipe (RTRP)

Pipe shall have a quick-burst strength greater than or equal to four times the normal working pressure of the pipe. The quick-burst strength test shall conform to the requirements of ASTM D 1599.

2.1.4.1 RTRP-I

RTRP-I shall conform to ASTM D 2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe shall be suitable for a normal working pressure of 1.03 MPa (150 psi) at 23 degrees C. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

2.1.4.2 RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

#### 2.1.5 Ductile-Iron Pipe

Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 1.03 MPa (150 psi), unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

#### 2.1.6 Steel Pipe

##### 2.1.6.1 Galvanized Steel Pipe

Galvanized steel pipe shall conform to ASTM A 53, standard weight.

##### 2.1.6.2 Protective Materials for Steel Pipe

Protective materials for steel pipe, except as otherwise specified, shall be mechanically applied in a factory or plant especially equipped for the purpose. The materials shall, unless otherwise indicated on the drawings, consist of one of the following for the indicated pipe material and size:

a. Pipe and fittings less than 80 mm (3 inches) in diameter shall be thoroughly cleaned of foreign material by wire brushing and solvent cleaning, and then given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203; threaded ends of pipe and fittings shall be adequately protected prior to coating.

b. Pipe 80 mm (3 Inches) or Larger, Not Galvanized:

   (1) Cement-mortar coating and lining shall conform to and shall be applied in conformance with AWWA C205. Cement-mortar coating and linings shall not be used for pipe less than 100 mm (4 inches) in diameter.

   (2) Coal-tar enamel lining, coating and wrapping shall conform to AWWA C203 for materials, method of application, tests and handling. Non-asbestos material shall be used for the outerwrap.

   (3) Cement-mortar lining, in lieu of coal-tar enamel lining, may be used with coal-tar enamel coating and wrapping. Cement-mortar lining shall conform to and shall be applied in conformance with AWWA C205.

#### 2.1.7 Copper Tubing

Copper tubing shall conform to ASTM B 88M, Type K, annealed.

### 2.2 FITTINGS AND SPECIALS

#### 2.2.1 Reinforced Concrete Pipe System

Fittings and specials required for closures, curves, bends, branches and connections to valves, pipe, or structures shall be approved by the Contracting Officer and conform to the details furnished by the manufacturer and to AWWA C300, AWWA C301, or AWWA C303, as applicable.

2.2.2 PVC Pipe System

a. For pipe less than 100 mm (4 inch) diameter, fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings; fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467; and fittings for elastomeric-gasket joint pipe shall be iron conforming to AWWA C110 or AWWA C111. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104.

b. For pipe 100 mm (4 inch) diameter and larger, fittings and specials shall be iron, bell end in accordance with AWWA C110, 1.03 MPa (150 psi) pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer; or fittings and specials may be of the same material as the pipe with elastomeric gaskets, all in conformance with AWWA C900. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Fittings shall be bell and spigot or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

2.2.3 RTRP and RPMP Pipe

Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to 150 mm (6 inches) shall conform to AWWA C950. Iron fittings shall be cement-mortar lined in accordance with AWWA C104 and shall conform to AWWA C110 and AWWA C111. Fittings shall be suitable for working and testing pressures specified for the pipe.

2.2.4 Ductile-Iron Pipe System

Fittings and specials shall be suitable for 1.03 MPa (150 psi) pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and AWWA C111. Fittings and specials for grooved and shouldered end pipe shall conform to AWWA C606. Fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Ductile iron compact fittings shall conform to AWWA C153. Ductile iron pipe shall have a factory or hand applied bonded coating.

2.2.5 Steel Pipe System

2.2.5.1 Galvanized Steel Piping

Steel fittings shall be galvanized. Screwed fittings shall conform to ASME B16.3. Flanged fittings shall conform to AWWA C207.

2.2.5.2 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

2.2.6 Copper Tubing System

Fittings and specials shall be flared and conform to ASME B16.26.

2.3 JOINTS

2.3.1 Gaskets for Reinforced Concrete Pipe

Rubber-gasket joints shall be of the type using a bell-and-spigot joint design of steel. The gaskets shall conform to AWWA C300, AWWA C301, or AWWA C303, as applicable.

2.3.2 Plastic Pipe Jointing

2.3.2.1 PE Pipe

Joints for pipe fittings and couplings shall be strong tight joints as specified for PE in Paragraph INSTALLATION. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendation, and as approved by the Contracting Officer.

2.3.2.2 PVC Pipe

Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer.

2.3.2.3 PVCO Pipe

Joints shall conform to ASTM D 3139. Elastomeric gaskets shall conform to ASTM F 477.

2.3.3 RPMP Pipe

Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D 4161.

2.3.4 RTRP Pipe

2.3.4.1 RTRP-I, Grade 1 and 2

Joints shall be bell and spigot with elastomeric gasket, mechanical coupling with elastomeric gasket, threaded and bonded coupling, or tapered bell and spigot with compatible adhesive. All RTRP-I materials shall be products of a single manufacturer.

2.3.4.2 RTRP-II, Grade 1 and 2

Joints shall be the bell and spigot type with elastomeric gasket, bell and spigot with adhesive, butt-jointed with adhesive bonded reinforced overlay, mechanical, flanged, threaded or commercially available proprietary joints, provided they are capable of conveying water at the pressure and temperature of the pipe.

2.3.5 Ductile-Iron Pipe Jointing

a. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.

b. Push-on joints shall conform to AWWA C111.

c. Rubber gaskets and lubricants shall conform to the applicable requirements of AWWA C111.

2.3.6 Steel Pipe Jointing

2.3.6.1 Mechanical Couplings

Mechanical couplings for steel pipe shall be the sleeve type, or when approved, the split-sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline.

2.3.7 Bonded Joints

For all ferrous pipe, a metallic bond shall be provided at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. The bond wire shall be Size 1/0 copper conductor suitable for direct burial shaped to stand clear of the joint. The bond shall be of the thermal weld type.

2.3.8 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

a. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

b. Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

#### 2.3.9 Copper Tubing Jointing

Joints shall be compression-pattern flared and shall be made with the specified fittings.

### 2.4 VALVES

#### 2.4.1 Ball Valves

Ball valves shall be designed for a working pressure of not less than 1.03 MPa (150 psi). Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

a. Valves smaller than 80 mm (3 inches) shall be all bronze and shall conform to MSS SP-110, Type 1, Class 150.

b. Valves 80 mm (3 inches) and larger shall be iron body, bronze mounted, and shall conform to AWWA C500. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.

#### 2.4.2 Indicator Post for Valves

Each valve shown on the drawings with the designation "P.I.V." shall be equipped with indicator post conforming to the requirements of NFPA 24. Operation shall be by a wrench which shall be attached to each post. Valve shall have a factory applied bonded coating.

### 2.5 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 5 mm. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location.

### 2.6 FIRE HYDRANTS

Hydrants shall be dry-barrel type conforming to AWWA C502 with valve opening at least 125 mm (5 inches) in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed and reasonably tight against leakage and with a breakable valve rod coupling and breakable flange connections located no more than 200 mm above the ground grade. Hydrants shall have a 150 mm (6 inch) bell connection, two 65 mm (2-1/2 inch) hose connections and one 115 mm (4-1/2 inch) pumper connection. Outlets shall have American

National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with 1 coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25 and 2 finish coats of silicone alkyd paint conforming to SSPC Paint 21, of the installation's standard colors or as directed by the Contracting Officer. Suitable bronze adapter for each outlet, with caps, shall be furnished. [AM#1] <u>Hydrants shall be installed adjacent to paved areas, not closer than 910 mm and not farther than 2130 mm from the roadway shoulder or curb line, where they will be accessible to fire department apparatus. Hydrants shall be installed with not less than 150 mm connection to the supply main, and valved at the connection. Barrels shall be long enough to permit at least 460 mm clearance between the center of the 115 mm pumper connection and grade. The ground shall be graded so that any surface drainage is away from the hydrant. Installation shall be in accordance with NFPA 24, except as modified herein. Pumper connection should be perpendiular to the street to allow straight lined connection to the pumper.</u>

## 2.7 MISCELLANEOUS ITEMS

### 2.7.1 Service Clamps

Service clamps shall have a pressure rating not less than that of the pipe to be connected and shall be either the single or double flattened strap type. Clamps shall have a galvanized malleable-iron body with cadmium plated straps and nuts. Clamps shall have a rubber gasket cemented to the body. Metallic clamps shall have a factory applied bonded coating.

### 2.7.2 Corporation Stops

Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints, compression pattern flared tube couplings, or wiped joints for connections to goosenecks.

### 2.7.3 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 1.03 MPa. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 67.8 Newton meters (50 foot-pound). Metallic tapping tee shall have a factory applied bonded coating. Tap-in shall be in accordance with AWWA M16.

### 2.7.4 Service Boxes

Service boxes shall be cast iron or concrete and shall be extension service boxes of the length required for the depth of the line, with either screw or slide-type adjustment. The boxes shall have housings of sufficient size to completely cover the service stop or valve and shall be complete with identifying covers.

#### 2.7.5 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

#### 2.7.6 Meters

Meters shall be the type and size shown on the drawings or specified. Meters of each of the various types furnished and installed shall be supplied by one manufacturer.

##### 2.7.6.1 Displacement Type

Meters shall conform to AWWA C700. Meter shall be positive displacement, oscillating piston, or pulsating disc type; magnetic drive with magnetic shielding, straight reading sealing register graduated in cubic meters, all bronze split case, integral strainer, threaded ends, and pulse switch initiator. Meter shall be suitable for accurately measuring and handling water at pressure, temperatures and flow rates to be encountered. The pulse initiator shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. It shall not provide less than 1 pulse per 378 liters.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed. Squeeze type mechanical cutters shall not be used for ductile iron.

#### 3.1.2 Adjacent Facilities

##### 3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 3 m from a sewer except where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 1.8 m from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe, for a distance of at least 3 m each side of the crossing, shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 900 mm horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 600 mm above the sewer main. Joints in the sewer main, closer horizontally than 900 mm to the crossing, shall be encased in concrete.

3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric wiring.

3.1.2.3 Copper Tubing Lines

Copper tubing shall not be installed in the same trench with ferrous piping materials.

3.1.2.4 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes.

3.1.3 Joint Deflection

3.1.3.1 Allowable for Reinforced Concrete Pipe

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall be 5 degrees for reinforced concrete pipe unless a lesser amount is recommended by the manufacturer. Long radius curves in reinforced concrete pipe shall be formed by straight pipe in which spigot rings are placed on a bevel. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflection does not exceed the maximum recommended by the pipe manufacturer. Short radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated specials specified.

3.1.3.2 Offset for Flexible Plastic Pipe

Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.

3.1.3.3 Allowable for Ductile-Iron Pipe

The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

3.1.3.4 Allowable for Steel Pipe

For pipe with bell-and-spigot rubber-gasket joints, maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets shall be 5 degrees unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

3.1.3.5 Allowable for RPMP Pipe

For pipe with bell and spigot rubber gasket joints, maximum allowable deflections from a straight line or grade shall be 4 degrees determined by the diameter, unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Water-line materials shall not be dropped or dumped into the trench. Abrasion of the pipe coating shall be avoided. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by and at the Contractor's expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

3.1.4.1 Reinforced Concrete Pipe Installation

Reinforced concrete pipe shall be installed in accordance with recommendations of the pipe manufacturer. Before laying reinforced concrete pipe, the outside surface of the spigot and the inside surface of the bell shall be cleaned and an acceptable vegetable-compound lubricant applied to the inside surface of the bell and to the rubber gasket. Where prescribed by the pipe manufacturer, the gasket shall be placed in the groove on the end of the pipe before the pipe is placed in the trench. After the pipe has been forced together, the position of the rubber gasket shall be checked with a feeler gauge in accordance with the pipe manufacturer's recommendations. Tapping of reinforced concrete cylinder pipe shall be done in accordance with the manufacturer's approved recommendations. Where the manufacturer recommends that the taps be made by attaching the rubber-gasketed saddle to the outside of the pipe using U-bolts, the saddle shall be grouted in if necessary, the mortar coating shall be chipped away, even with the hole in the saddle plate. The exposed circumferential wires shall be removed and the cylinder and concrete core drilled out, and the steel saddle and U-bolts shall be protected by concrete encasement.

3.1.4.2 Plastic Pipe Installation

RTRP shall be installed in accordance with ASTM D 3839. RPMP shall be installed in accordance with the manufacturer's recommendations. PE Pipe shall be installed in accordance with ASTM D 2774. PVC pipe shall be installed in accordance with AWWA M23.

3.1.4.3 Piping Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA Work Practices.

3.1.4.4 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

3.1.4.5 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.5 Jointing

3.1.5.1 Reinforced Concrete Pipe Requirements

The inside and outside annular spaces between abutting sections of concrete pipe shall be filled with rich cement mortar in accordance with the pipe manufacturer's recommendations. Excess mortar shall be removed from interior annular spaces, leaving a smooth and continuous surface between pipe sections. Exposed portions of steel joint rings shall be protected from corrosion by a metallic coating or by an approved nonmetallic coating. Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the pipe manufacturer's recommendations.

3.1.5.2 PE Pipe Requirements

Jointing shall comply with ASTM D 2657, Technique I-Socket Fusion or Technique II-Butt Fusion.

3.1.5.3 PVC Plastic Pipe Requirements

a. Pipe less than 100 mm (4 inch) diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with ASTM F 477 and as specified. Pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. The gasket and ring groove in the bell or coupling shall match. The manufacturer of the pipe or fitting shall supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall use sockets conforming to ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.

b. Pipe 100 through 300 mm diameter: Joints shall be elastomeric gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 100 mm (4 inch) diameter with configuration using elastomeric ring gasket.

c. Pipe 350 through 900 mm diameter: Joints shall be elastomeric gasket push-on joints made in accordance with AWWA M23.

3.1.5.4 RTRP I, RTRP II and RPMP Pipe

a. RTRP I: Assembly of the pipe shall be done in conformance with the manufacturer's written instruction and installation procedures. Field joints shall be prepared as specified by the pipe manufacturer. Several pipe joints having interference-fit type couplings may be field bonded and cured simultaneously. However, the pipe shall not be moved and additional joints shall not be made until the previously laid joints are completely cured. Joints not having interference-fit type coupling shall be fitted with a clamp which shall hold the joint rigidly in place until the joint cement has completely cured. The clamps shall have a protective material on the inner surface to prevent damage to the plastic pipe when the clamp is tightened in place. The pipe manufacturer shall provide a device or method to determine when the joint is pulled against the pipe stop. Additionally, the pipe manufacturer shall furnish a gauge to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. All pipe ends shall be gauged. Factory certified tests shall have been satisfactorily performed to verify that short-term rupture strength is 10.3 MPa (1,500 psi) or greater when carried out in accordance with ASTM D 1599. At any ambient temperature, field bonded epoxy-cemented joints shall be cured with a self-regulating, thermostatically temperature controlled, electrical heating blanket for the time and temperature recommended by the manufacturer for the applicable size and type of joint, or by an alternate heating method recommended by the manufacturer and approved by the Contracting Officer. The joint sections shall not be moved during heating, or until the joint has cooled to ambient temperature.

b. RTRP II: A reinforced overlay joint shall be used to join sections together through a placement of layers of reinforcement fiberglass roving, mat, tape or fabric thoroughly saturated with compatible catalyzed resin.

c. RPMP: Bell and spigot gasket-sealing coupling shall be used to connect pipes. The spigot shall be lubricated prior to push-together assembly.

d. Fittings and Specials for RTRP and RPMP Pipe: Metal to RTRP and RPMP pipe connections shall be made by bolting steel flanges to RTRP and RPMP pipe flanges. Cast-iron fitting with gasket bell or mechanical joint may be used with RTRP if pipe has cast iron outside diameter. Steel flanges shall be flat-faced type. Where raised-face steel flanges are used, spacer rings shall be used to provide a flat-face seat for RTRP and RPMP pipe flanges. A full-face Buna "N" gasket 3 mm (1/8 inch) thick with a shore hardness of 50-60 shall be used between all flanged connections. The RTRP and RPMP pipe flange shall have raised sealing rings. Flat washers shall be used under all nuts and bolts on RTRP and RPMP pipe flanges. Bolts and nuts shall be of noncorrosive steel and torqued to not more than 135 Newton meters. Flanges shall not be buried. A concrete pit shall be provided for all flanged connections.

3.1.5.5 Ductile-Iron Pipe Requirements

Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines or AWWA C606 for grooved and shouldered pipe above ground or in pits.

3.1.5.6 Galvanized Steel Pipe Requirements

Screw joints shall be made tight with a stiff mixture of graphite and oil, inert filler and oil, or with an approved graphite compound, applied with a brush to the male threads only. Compounds shall not contain lead.

3.1.5.7 Copper Tubing Requirements

Joints shall be made with flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

3.1.5.8 Bonded Joints Requirements

Bonded joints shall be installed in accordance with details specified for joints in paragraph JOINTS.

3.1.5.9 Isolation Joints and Dielectric Fittings

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph JOINTS. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm thickness of coal tar over all fitting surfaces.

3.1.5.10 Transition Fittings

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

3.1.6 Installation of Service Lines

Service lines shall include the pipeline connecting building piping to water distribution lines to the connections with the building service at a point approximately 1.5 m outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 1.5 m from the site of the proposed building at a point designated by the Contracting Officer. Such service lines shall be closed with plugs or caps. All service stops and valves shall be provided with service boxes. Service lines shall be constructed in accordance with the following requirements:

3.1.6.1 Service Lines 50 mm (2 Inches) and Smaller

Service lines 50 mm (2 inches) and smaller shall be connected to the main by a directly-tapped corporation stop or by a service clamp. A corporation stop and a copper gooseneck shall be provided with either type of connection. Maximum sizes for directly-tapped corporation stops and for outlets with service clamps shall be as in TABLE I. Where 2 or more gooseneck connections to the main are required for an individual service, such connections shall be made with standard branch connections. The total clear area of the branches shall be at least equal to the clear area of the service which they are to supply.

TABLE I. SIZE OF CORPORATION STOPS AND OUTLET

| Pipe Size mm | Corporation Stops, mm For Ductile-Iron Pipe | Outlets w/Service Clamps, mm Single & Double Strap |
|---|---|---|
| 80 | -- | 25 |
| 100 | 25 | 25 |
| 150 | 32 | 40 |
| 200 | 40 | 50 |
| 250 | 40 | 50 |
| 300 & larger | 50 | 50 |

NOTE:

a. Service lines 40 mm (1-1/2 inches) and smaller shall have a service stop.

b. Service lines 50 mm (2 inches) in size shall have a gate valve.

3.1.6.2 Service Lines Larger than 50 mm (2 Inches)

Service lines larger than 50 mm (2 inches) shall be connected to the main by a tapped saddle, tapping sleeve and valve, service clamp or reducing tee, depending on the main diameter and the service line diameter, and shall have a gate valve. Lines 80 mm (3 inches) and larger may use rubber-seated butterfly valves as specified above, or gate valves.

3.1.6.3 Service Lines for Sprinkler Supplies

Water service lines used to supply building sprinkler systems for fire protection shall be connected to the water distribution main in accordance with NFPA 24.

3.1.7 Field Coating and Lining of Pipe

3.1.7.1 Galvanized Steel Pipe, Field Coating

Field joints shall be given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203. The tests of the coating shall conform to AWWA C203, and any flaws or holidays found in the coating of pipe and joints shall be repaired by patching or other approved means; the repaired areas shall be at least equal in thickness to the minimum coating required for the pipe.

3.1.8 Setting of Fire Hydrants, Meters, Valves and Valve Boxes

3.1.8.1 Location of Fire Hydrants

Fire hydrants shall be located and installed as shown. Each hydrant shall be connected to the main with a 150 mm (6 inch) branch line having at least as much cover as the distribution main. Hydrants shall be set plumb with pumper nozzle facing the roadway, with the center of the lowest outlet not less than 450 mm above the finished surrounding grade, and the operating nut not more than 1.2 m above the finished surrounding grade. Fire hydrants designated on the drawings as low profile shall have the lowest outlet not less than 450 mm above the finished surrounding grade, the top of the hydrant not more than 600 mm above the finished surrounding grade. Except where approved otherwise, the backfill around hydrants shall be thoroughly compacted to the finished grade immediately after installation to obtain beneficial use of the hydrant as soon as practicable. The hydrant shall be set upon a slab of concrete not less than 100 mm thick and 400 mm square. Not less than 2 cubic meters of free-draining broken stone or gravel shall be placed around and beneath the waste opening of dry barrel hydrants to ensure drainage.

3.1.8.2 Location of Meters

Meters and meter boxes shall be installed at the locations shown on the drawings. The meters shall be centered in the boxes to allow for reading and ease of removal or maintenance.

3.1.8.3 Location of Valves

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Check, pressure reducing, vacuum, and air relief valves shall be installed in valve pits. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be tamped around each valve box or pit to a distance of 1.2 m on all sides of the box, or the undisturbed trench face if less than 1.2 m.

3.1.8.4 Location of Service Boxes

Where water lines are located below paved streets having curbs, the boxes shall be installed directly back of the curbs. Where no curbing exists, service boxes shall be installed in accessible locations, beyond the limits of street surfacing, walks and driveways.

3.1.9 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

3.1.10 Thrust Restraint

Plugs, caps, tees and bends deflecting 11.25 degrees or more, either vertically or horizontally, on waterlines 100 mm (4 inches) in diameter or larger, and fire hydrants shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

3.1.10.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.10.2 Restrained Joints

For ductile-iron pipe, restrained joints shall be designed by the

Contractor or the pipe manufacturer in accordance with DIPRA-Restraint Design.

## 3.2 HYDROSTATIC TESTS

Where any section of a water line is provided with concrete thrust blocking for fittings or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved.

### 3.2.1 Pressure Test

After the pipe is laid, the joints completed, fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 1.38 MPa. Water supply lines designated on the drawings shall be subjected for 1 hour to a hydrostatic pressure test of 1.38 MPa. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, hydrants, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions is encountered:

a. Wet or unstable soil conditions in the trench.

b. Compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.

c. Maintaining the trench in an open condition would delay completion of the project.

The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

### 3.2.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to not less than 1.38 MPa pressure. Water supply lines designated on the drawings shall be subjected to a pressure equal to 1.38 MPa. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section, necessary to maintain pressure within 34.5 kPa (5 psi) of the specified leakage test pressure after the pipe has been filled with water and the air expelled. Piping installation will not be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

L = 0.0001351ND(P raised to 0.5 power)

L = Allowable leakage in gallons per hour
N = Number of joints in the length of pipeline tested
D = Nominal diameter of the pipe in inches
P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

#### 3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

#### 3.2.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be as specified. Replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

a. Pressure test and leakage test may be conducted concurrently.

b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

### 3.3 BACTERIAL DISINFECTION

#### 3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected as specified. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph MISCELLANEOUS ITEMS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the above specified chlorinating material in solution. The agent shall not be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. Valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each fire hydrant on the line shall be opened and closed several times. From several points in the unit, personnel from the Contractor's commercial laboratory shall take at least 3 water samples from different points, approved by the Contracting Officer, in proper sterilized containers and perform a bacterial examination in accordance with state approved methods. The commercial laboratory shall be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

## 3.4 CATHODIC PROTECTION

Cathodic Protection shall be installed on all buried metallic water lines, fire protection lines, valves, fittings, building stubouts, building risers and meters in accordance with Specification Section 13110 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE) and AFI 32-1054 and ETL 91-6. All buried metallic pipes, valves, fittings, risers, etc. shall have a minimum 20 mil thick bonded coating installed.

## 3.5 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

# SECTION 02555

# PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM
**12/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 105/A 105M | (2001) Carbon Steel Forgings for Piping Applications |
| ASTM A 106 | (1999el) Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A 183 | (1998) Carbon Steel Track Bolts and Nuts |
| ASTM A 234/A 234M | (2000) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 536 | (1984; R 1999el) Ductile Iron Castings |
| ASTM B 62 | (1993) Composition Bronze or Ounce Metal Castings |
| ASTM B 88M | (1999) Seamless Copper Water Tube (Metric) |
| ASTM C 518 | (1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus |
| ASTM C 591 | (1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM D 1384 | (1997a) Corrosion Test for Engine Coolants in Glassware |
| ASTM D 1784 | (1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |

| | |
|---|---|
| ASTM D 2000 | (1999) Rubber Products in Automotive Applications |
| ASTM D 2241 | (2000) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) |
| ASTM D 2564 | (1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D 3139 | (1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals |
| ASTM D 3350 | (2000) Polyethylene Plastics Pipe and Fittings Materials |
| ASTM D 5686 | (1995) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Pipe Fittings, Adhesive Bonded Joint Type Epoxy Resin, for Cendensate Return Line |
| ASTM F 477 | (1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe |

AMERICAN WATER WORKS ASSOCIATION(AWWA)

| | |
|---|---|
| AWWA C606 | (1997) Grooved and Shouldered Joints |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.18 | (1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.22 | (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (1988) Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B31.1 | (1998) Power Piping |
| ASME BPVC SEC IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |

COPPER DEVELOPMENT ASSOCIATION (CDA)

| | |
|---|---|
| CDA Tube Handbook | (1995) Copper Tube Handbook |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-73 | (1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings |

## 1.2 SYSTEM DESCRIPTION

The system consists of a buried prefabricated chilled water distribution system including service connections to a point 150 mm inside of the building. The contract drawings show the specific arrangement of piping, sizes and grades of pipe, and other details. The system is designed for an operating pressure of 862 kPa and an operating temperature of 55.5 degrees C for chilled water.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Distribution System; G, ED.

Detail drawings consisting of fabrication and assembly drawings, for all parts of the work in sufficient detail to check conformity with the requirements of the contract documents, prior to installation. Detail drawings shall also contain complete piping, wiring and schematic diagrams and any other details to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, method of compensation for pipe expansion and contraction, anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances required for maintenance and operation. The drawings shall clearly identify any proposed deviations from the requirements of the contract documents.

SD-03 Product Data

Distribution System; G, ED.

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

SD-07 Certificates

Distribution System.

The manufacturer's or system fabricator's written certification stating that the distribution system furnished meets all the requirements of this specification.

Welding.

Prior to welding operations, a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

SD-10 Operation and Maintenance Data

Distribution System; G, ED.

Six copies of operation and 6 copies of maintenance manuals for the equipment furnished, 1 complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for equipment startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the equipment system as installed. Manuals shall be approved prior to the field performance testing.

## 1.4 DELIVERY AND STORAGE

After delivery to the jobsite, all materials and equipment shall be protected from anything which could cause damage to the material or equipment. Pipe shall be sealed at each end to keep the interior clean and free of dirt and debris. Fittings shall be kept together and their interior surfaces shall remain clean. Insulation shall be kept dry and clean.

## 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

## 1.6 WELDING

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The

Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Welding and nondestructive testing procedures are specified in Section {AM#0001} 05090 WELDING PRESSURE PIPING.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

System components shall be standard products of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The system shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2 PIPING AND CASING MATERIALS

2.2.1 General

Metallic pressure pipe, fittings, and piping accessories shall conform to the requirements of ASME B31.1 and shall be types suitable for the temperature and pressure of the water.

2.2.2 Piping

2.2.2.1 Steel Pipe

Piping shall conform to ASTM A 53/A 53M, Grade B, standard weight, black or to ASTM A 106, Grade B, standard weight.

2.2.2.2 Copper Tubing

Copper tubing shall conform to ASTM B 88M , Type K or L.

2.2.2.3 Reinforced Thermosetting Resin Pipe (RTRP)

RTRP pipe shall conform to ASTM D 5686.

2.2.2.4 Polyvinyl Chloride (PVC) Pipe

PVC pipe shall conform to ASTM D 2241 with a Standard Thermoplastic Pipe Dimension Ratio (SDR) of 26 and PVC 1120 or 1220 as the material.

2.2.2.5 Joints and Fittings for Copper Tubing

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75M . Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.2.3 Casings

2.2.3.1 Polyvinyl Chloride (PVC) Casing

PVC casings shall conform to ASTM D 1784, Class 12454-B with a minimum thickness equal to the greater of 1/100 the diameter of the casing or 1.50 mm.

2.2.3.2 Polyethylene (PE) Casing

Polyethylene casings shall conform to ASTM D 3350, Type III, Class C, Category 3 or 4, Grade P 34 with thickness as follows:

| Casing Diameter (in mm) | Minimum Thickness (in mm) |
|---|---|
| 250 and smaller | 3 |
| 250 to 450 | 4 |
| 450 to 600 | 5 |
| over 600 | 6 |

2.2.3.3 Reinforced Thermosetting Resin Pipe (RTRP) Casing

RTRP casing shall be of the same material as the pipe, with casing thickness as follows:

| Casing Diameter (in mm) | Minimum Thickness (in mm) |
|---|---|
| 200 and smaller | 1.2 |
| 250 | 2 |
| 300 | 2.7 |
| 350 | 2.9 |
| 400 to 450 | 3 |
| 500 | 3.2 |
| 600 | 3.9 |

2.3 PIPING CONNECTIONS

2.3.1 Steel Pipe

Steel pipe smaller than 20 mm (3/4 inch) may be threaded; otherwise, all steel pipe shall be welded. Steel welding fittings shall conform to the requirements of ASTM A 105/A 105M or ASTM A 234/A 234M. Welding fittings shall also conform to ASME B16.9 for buttweld fittings and ASME B16.11 for socket-weld fittings. Long radius buttwelding elbows conforming to ASME B16.9 shall be used whenever space permits. Pipe Threads shall conform to ASME B1.20.1. Pipe to be threaded shall be schedule 80.

2.3.2 Copper Pipe

Copper pipe shall be brazed or connected using an insulated pipe coupling. Wrought copper or cast copper alloy solder joint pressure fittings shall conform to MSS SP-73. Insulated pipe couplings for copper pipe shall be cast bronze containing an O-ring seal on each end and shall be jacketed and sealed to act as an expansion joint.

## 2.4 END SEALS

### 2.4.1 General

Each preinsulated section of piping shall have a complete sealing of the insulation to provide a permanent water and vapor seal at each end of the preinsulated section of piping. Preinsulated sections of piping modified in the field shall be provided with an end seal which is equivalent to the end seals furnished with the preinsulated section of piping. End seals must be tested and certified in accordance with paragraph Casing and End Seal Testing and Certification.

### 2.4.2 Types

End seals provided shall be one of the following types:

a. Carrying the outer casing over tapered pipe insulation ends and extending it to the carrier pipe. Sufficient surface bonding area shall be provided between the casing and the carrier pipe.

b. Using specially designed molded caps made of polyethylene or rubber of standard manufactured thickness. A minimum 40 mm surface bonding area shall be provided between the cap and both the casing and carrier pipe.

c. Using elastomer-ring end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe.

d. Using a waterproof mastic seal vapor barrier over the exposed insulation ends.

e. Shrink sleeves.

### 2.4.3 Casing and End Seal Testing and Certification

Testing and certification procedures by an independent testing laboratory shall demonstrate that casings and end seals are capable of resisting penetration of water into the casing and insulation. The test shall be performed on the type of prefabricated system to be furnished. If more than one type of prefabricated system is to be used, then the tests shall be performed on each type. The test shall consist of hot and cold cycle testing followed by immersion in a water filled chamber with a head pressure. The hot and cold cycle testing shall consist of 14 days of temperature cycling. A fluid with a temperature of 5 degrees C shall circulate through the carrier pipe alternating every 24-hours with a fluid with a temperature of 95 degrees C circulating through the carrier pipe for a low temperature hot water or dual temperature service or 24 degrees for a chilled water service. While the hot and cold cycle test is being performed, the test sample is either buried or encased in dry bedding sand with a minimum of 300 mm of sand all around the test sample. The carrier pipe size of the test sample shall be 80 mm (3 inches) in diameter and shall be restrained during the test period. The insulation thickness shall not exceed the maximum thickness provided for the piping in the project. Transition time for temperature cycle testing shall not exceed 15 minutes in going from cold to hot and 30 minutes in going from hot to cold. The fluid in the carrier pipe may be water, oil or heat transfer fluid. Following the hot and cold cycling test, the test sample shall be immersed in a water filled chamber. The pressure on the highest point of the test sample shall not be less than 60 kPa subjected over the entire length of the 2.4 m test sample of prefabricated pipe. The water shall contain a dye penetrant, which will be used to check for end seal leakage. The pressure in the chamber must be held for not less than 48 hours. Upon completion of this pressure test, the test sample shall be cut open. With the use of a light that will readily show the presence of the dye that was in the water, the test sample shall be inspected. Evidence of the dye inside the test sample shall indicate that the end seal is not acceptable and cannot be certified.

## 2.5 INSULATION

The Contractor shall comply with EPA requirements in accordance with Section {AM#0001} 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 2.5.1 Factory Applied Insulation

Prefabricated pipe and fittings shall be insulated in the factory. Foam insulation for prefabricated insulated pipe and fittings shall be polyurethane foam meeting the requirements of ASTM C 591 having a density not less than 32 kg per cubic meter. The polyurethane foam shall completely fill the annular space between the carrier pipe and the casing. Insulation thickness shall be a minimum of 40 mm. The insulation thermal conductivity factor shall not exceed the numerical value of 0.02 W/mK (0.15 Btu-inch/square foot-degree F-hour) at 24 degrees C, when tested in accordance with ASTM C 518. Manufacturer shall certify that the insulated pipe is free of insulation voids.

### 2.5.2 Field Applied Insulation

Field applied insulation for fittings, and field casing closures, if required, and other piping system accessories shall be polyurethane matching the pipe insulation. Thickness shall match adjacent piping insulation thickness. Buried fittings and accessories shall have field applied polyurethane insulation to match adjacent piping and shall be protected with a covering matching the pipe casing. Shrink sleeves with a minimum thickness of 1.3 mm shall be provided over casing connection joints.

# PART 3 EXECUTION

## 3.1 INSTALLATION

For all preinsulated, prefabricated systems, the Contractor shall obtain the services of a trained representative of the pipe system manufacturer to instruct the Contractor's work forces in the installation procedures to ensure that the system is installed in accordance with the manufacturer's published instructions and the plans and specifications. The manufacturer's representative shall be a person who regularly performs such duties for the manufacturer. The Contractor shall furnish the Contracting Officer a list of names of personnel trained and certified by the pipe system manufacturer in the installation of this system. Only personnel whose names appear on the list will be allowed to install the system. The list shall not be more than 1 year old.

3.2 PIPING SYSTEMS

3.2.1 Buried Insulated Systems

Buried insulated systems shall consist of carrier pipe, insulation, casing, end seals, fittings and accessories as specified.

3.3 THRUST BLOCKS

Thrust blocks shall be installed at the locations shown or recommended by the pipe system manufacturer. Thrust blocks may not be required on all systems, and the need for thrust blocks shall be as recommended by the system manufacturer. Thrust blocks, if necessary, shall be installed at all changes in direction, changes in size, valves and terminal ends, such as plugs, caps and tees. Thrust blocks shall be concrete having a compressive strength of not less than 14 MPa (2000 psi) after 28 days and shall be in accordance with Section 03300CAST-IN-PLACE STRUCTURAL CONCRETE. Thrust blocks shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and the thrust bearing sides of the thrust blocks shall be poured directly against undisturbed earth. The sides of the thrust blocks not subject to thrust may be poured against forms. Thrust blocks shall be placed so that the joints for all fittings will be accessible for repair wherever possible. No pipe joint shall be embedded in concrete unless the assembly has previously been hydrostatically tested. The thrust blocks shall provide for transfer of thrusts and reactions without exceeding the allowable stress of the concrete and shall be installed in accordance with pipe manufacturer's instructions. In muck or peat, all thrusts shall be resisted by piles or tie rods to solid foundations or by removal of peat or muck which shall be replaced with ballast of sufficient stability to resist thrusts.

3.4 INSTALLATION OF PIPING SYSTEMS

The piping system furnished shall be installed in accordance with the piping system manufacturer's instructions. Piping shall be installed without springing or forcing other than what has been calculated for cold spring. Pipe ends shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Nonmetallic pipe cut in the field shall be machined to fit couplings or joints and shall be coated or treated to match standard factory coated ends. Copper tubing shall not be installed in the same trench with ferrous piping materials. When nonferrous metallic pipe (e.g., copper tubing) crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes. Connections between different types of pipe and accessories shall be made with transition fittings approved by the manufacturer of the piping system.

3.4.1 Pitching of Horizontal Piping

Horizontal piping shall be pitched at a grade of not less than 40 mm in 1 m toward the drain points unless otherwise indicated.

3.4.2 Open Ends

Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system.

3.4.3 Cutting Prefabricated Piping Sections

Where prefabricated pipe sections are field cut, new end seals similar to the factory applied end seal shall be provided and installed in accordance with the manufacturer's instructions.

3.4.4 Joints

3.4.4.1 Welded Joints

Welded joints between sections of pipe and between pipe and fittings shall be provided where specified or indicated.

3.4.4.2 Threaded Joints

Threaded joints shall not be used belowground. Joints shall be made tight with polytetrafluoroethylene tape applied to the male threads only. Not more than 3 threads shall show after the joint is made up.

3.4.4.3 Brazed Joints

Brazed joints for copper pipe and fittings shall conform to CDA Tube Handbook. Brazing alloys melting above 593.3 degrees C (1100 degrees F) shall be utilized.

3.4.4.4 Nonmetallic Pipe Joints

Nonmetallic pipe joints shall be installed in accordance with the written instructions of the manufacturer.

3.4.5 Expansion Loops

If expansion compensation is needed, expansion loops and expansion bends (Z- and L- type) shall be factory fabricated of casing, insulation, and carrier piping identical to that furnished for straight runs. Expansion loops and bends shall be properly designed in accordance with the allowable stress limits indicated in ASME B31.1 for the type of pipe used. Expansion loops and bends shall be shipped to the jobsite in the maximum size sections feasible to minimize the number of field joints. The expansion loops and bends casing and insulation where applicable, shall be suitably sized to accommodate pipe movement. Field joints shall be made in straight runs of the expansion loops and bends, and the number shall be kept to a minimum. For steel pipe, cold springing shall not be allowed when sizing the expansion loops and bends, but piping shall be cold sprung one-half the calculated maximum operational expansion during field assembly. Pipe stress in expansion loops and bends shall conform to the requirements for expansion loops specified in ASME B31.1.

### 3.4.6 Anchors

Anchor design shall be in accordance with the published data of the manufacturer and for prefabricated systems shall be factory fabricated by the prefabricated system manufacturer. In all cases, the design shall be such that water penetration, condensation, or vapor transmission will not wet the insulation.

### 3.4.7 Field Casing Closures

Field insulation and encasement of joints shall be accomplished after the visual and pressure tests specified are completed. Field insulation and encasement shall be in accordance with the manufacturer's written instructions. Thickness dimensions of the insulation and casing materials shall not be less than those of the adjoining prefabricated section. Insulating material shall be foamed in place polyurethane. Care should be taken to ensure that field closures are made under conditions of temperature and cleanliness required to produce a sound, continuous vapor barrier. A standard polyethylene heat shrink sleeve shall be installed over the casing and shall have a 150 mm minimum overlap at each end.

### 3.4.8 Underground Warning Tape

Underground warning tape shall be buried above the piping during the trench backfilling and shall be buried approximately 300 mm deep. Tape shall be polyethylene tape with metallic core. Tape shall be 150 mm wide and be printed with repetitive caution warnings along its length. Tapes shall be yellow in color with black letters. Tape color and lettering shall not be affected by moisture or other substances contained in the backfill material.

### 3.4.9 Markers for Underground Piping

Markers for underground piping shall be placed as indicated approximately 600 mm to the right of the distribution system and referenced to the flow direction in the supply line. The marker shall be concrete 150 mm square or round section 600 mm long. The top edge of the marker shall have a minimum 10 mm chamfer all around. The letters CHW shall be impressed or cast on the top of the markers to indicate the type of system that is being identified. Each letter shall be formed with a V-shaped groove and shall have a width of stroke at least 6 mm at the top and depth of 6 mm. The top of the marker shall protrude not more than 25 mm above finished grade.

## 3.5 EARTHWORK

Earthwork shall be performed in accordance with Section 02316A EXCAVATION,

TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

## 3.6 ELECTRICAL WORK

Electrical work shall be performed in accordance with either Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND .

## 3.7 TESTING

Tests shall be conducted before, during, and after installation of the system. All instruments, equipment, facilities, and labor required to properly conduct the tests shall be provided by the Contractor. Test pressure gauges for a specific test shall have dials indicating not less than 1-1/2 times nor more than 2 times the test pressure. It shall be the Contractor's responsibility to make the pipe system workable at his expense.

### 3.7.1 Metallic Pipe Welds

An approved independent testing firm or firms regularly engaged in radiographic testing shall perform a radiographic examination of the field welds. The radiographic testing shall be performed in accordance with ASME B31.1. All radiographs shall be reviewed and interpreted by a Certified Level III Radiographer employed by the testing firm. Any welds found to be unacceptable shall be removed, rewelded and radiographically reexamined in accordance with the above criteria. Such repair and reexamination shall be accomplished at no cost to the Government.

### 3.7.2 Carrier Pipe Cleaning and Testing

Distribution piping shall be tested as required before backfilling and with all joints exposed. The area between joints may be backfilled as necessary to prevent pipe movement.

#### 3.7.2.1 Cleaning Carrier Pipe

Prior to testing, the interior of the carrier pipe shall be cleaned of foreign materials by thorough flushing with clean water. Water shall be circulated at a velocity between 2 and 3 m/s (7 and 10 feet per second) for a minimum of 4 hours. If required, temporary and/or supplementary pumps shall be provided to ensure that required velocity is achieved. System strainers shall be cleaned after the flushing operation is complete. Temporary strainers shall be installed as required. After flushing, the water shall remain in the piping system for testing of the system. All air shall be removed from the system prior to starting the tests.

#### 3.7.2.2 Hydrostatic Pressure Cycling and Tests

Hydrostatic pressure cycling shall have 4 cycles. Each cycle shall consist of a 10 minute period at 1000 kPa followed by a 5 minute period at a pressure less than 350 kPa. The next cycle shall begin immediately following the completion of the previous cycle. Pressure rise and drop shall not exceed 690 kPa per minute. The pressure gauge shall be located and the pressure measured at the opposite end of the system from where the pressure is applied. After completion of the hydrostatic pressure cycling, the first hydrostatic pressure test shall be performed. During the first hydrostatic pressure test, the system shall be proven tight at a pressure of 1-1/2 times the working pressure up to 1000 kPa. This pressure shall be held for a minimum of 1 hour. The method of pressurizing the system shall be disconnected from the system before starting the 1 hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of pressure loss shall be determined, corrected and the hydrostatic pressure cycling and first hydrostatic pressure test shall be repeated until the system can hold the required pressure for at least 1 hour. After successful completion of the first hydrostatic pressure test, the water shall be drained out of the piping system and the piping system filled with treated water as defined in paragraph TREATED WATER for the remaining tests and for permanent operation of the system. The hydrostatic pressure cycling and tests shall be repeated after the system has been filled with treated water, using the same test conditions and criteria.

3.7.2.3 Operational Test

Operational test shall be performed on the complete system or testable portions thereof. The test shall be conducted with full design flows and operating temperatures in all runs of piping as if in service, to demonstrate satisfactory function and operating effectiveness. The operational test will have two cycles. Each cycle shall consist of a 6-hour period with treated water in the system at the maximum operating temperature of 55.5 degrees C and maximum flow rate, and a period of at least 6-hours with no flow. The Contractor shall supply temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired temperatures and flow rates. Water shall be circulated through supply lines and returned through the return piping to demonstrate that the pressure drop is compatible with the flow rate and size of pipe and to show that obstructions do not exist in the piping system. Any unusual indicated pressure drop will be investigated and any obstructions removed. Any leaks found shall be repaired. After any obstructions have been removed and any leaks repaired, the operational test shall be repeated until successfully passed.

3.7.2.4 Final Hydrostatic Test

After successful completion of the operational test, the system shall be pressurized to 1-1/2 times the working pressure up to 1000 kPa. This pressure shall be held for a minimum of 4 hours. Means of pressurizing shall be disconnected prior to the start of the 4-hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of the pressure loss shall be determined, corrected, and all of the hydrostatic pressure cycling and tests repeated.

-- End of Section --

SECTION 02721

SUBBASE COURSES

**AMENDMENT NO. 0001**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 29/C 29M | (1997) Bulk Density ("Unit Weight") and Voids in Aggregates |
| ASTM C 117 | (1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C 131 | (1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C 136 | (1996) Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 75 | (1987; R 1997) Sampling Aggregates |
| ASTM D 422 | (1963; R 1998) Particle-Size Analysis of Soils |
| ASTM D 1556 | (1990; R 1996el) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 1557 | (1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.)) |
| ASTM D 2922 | (1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 3017 | (1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 4318 | (1998) Liquid Limit, Plastic Limit, and |

Plasticity Index of Soils

ASTM E 11 (1995) Wire-Cloth Sieves for Testing Purposes

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Standard Specification for Construction of Highways, Streets and Bridges, 1993.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment.

List of proposed equipment to be used in performance of construction work, including descriptive data.

[AM#1] Material Source

[AM#1] Provide a list of material suppliers.

Waybills and Delivery Tickets.

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all aggregates actually used.

SD-06 Test Reports

Sampling and Testing.

[AM#1] Copies of initial and in-place test results [AM#1] for the following: [AM#1] _

[AM#1]a. Sieve Analysis

[AM#1]b. Liquid Limit and Plasiticity Index

[AM#1]c. Moisture-Density Determination

[AM#1]d. Density Tests

1.3 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, Method C. In this specification, degree of compaction shall be a percentage of laboratory maximum density.

## 1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved testing laboratory in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Tests shall be performed at the specified frequency. No work requiring testing will be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements.

### 1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

### 1.4.2 Tests

#### 1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

#### 1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

#### 1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture shall be determined in accordance with ASTM D 1557, Method C.

#### 1.4.2.4 Density Tests

Density shall be field measured in accordance with ASTM D 1556 or ASTM D 2922. The calibration curves shall be checked and adjusted, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and, when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration, in ASTM D 2922, on each different type of material to be tested at the beginning of a job and at intervals as directed.

#### [AM#1] 1.4.2.5 Wear Test

Wear tests shall be made on subbase course material in conformance with ASTM C 131.

#### 1.4.2.6 Weight of Slag

Weight per cubic meter of slag shall be determined in accordance with ASTM C 29/C 29M on the subbase course material.

### 1.4.3 Testing Frequency

#### 1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation.

a. Sieve Analysis including 0.02 mm size material
b. Liquid limit and plasticity index moisture-density relationship
c. Wear
d. Moisture density curve.

#### 1.4.3.2 In-Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted subbase course. Samples shall be taken for each 1,000 square meters of each layer of material placed in each area.

a. Sieve Analysis including 0.02 mm size material
b. Field Density
c. Moisture liquid limit and plasticity index
d. Wear

### 1.4.4 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted subbase course.

## 1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

## 1.6 EQUIPMENT

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Subbase Course

Aggregates shall consist of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Aggregates shall be durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Material retained on the 4.75 mm sieve shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested as specified in ASTM C 131. Aggregate shall be reasonably uniform in density and quality. Slag shall be an air-cooled, blast-furnace product having a dry weight of not less than 1050 kg/cubic meter. Aggregates shall have a maximum size of 75 mm and shall be within the limits specified as follows:

Maximum Allowable Percentage by Weight
Passing Square-Mesh Sieve

| Sieve Designation | No. 3 |
|---|---|
| 2 mm | -- |
| 0.075 mm | 15 |

Particles having diameters less than 0.02 mm shall not be in excess of 3 percent by weight of the total sample tested as determined in accordance with ASTM D 422. The portion of any blended component and of the completed course passing the 0.425 mm shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5. Contractor option to use THD Item 247, Type A, Grade I/II base in lieu of specified material.

# PART 3 EXECUTION

## 3.1 OPERATION OF AGGREGATE SOURCES

All clearing, stripping and excavating work involved in the opening or operation of aggregate sources shall be performed by the Contractor. Aggregate sources shall be opened to working depth in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Materials excavated from aggregate sources shall be obtained in successive cuts extending through all exposed strata. All pockets or strata of unsuitable materials overlying or occurring in the deposit shall be wasted as directed. The methods of operating aggregate sources and the processing and blending of the material may be changed or modified by the Contracting Officer, when necessary, in order to obtain material conforming to specified requirements. Upon completion of work, aggregate sources on Government reservations shall be conditioned to drain readily, and shall be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws and authorities.

## 3.2 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer so as to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

## 3.3 PREPARATION OF UNDERLYING MATERIAL

Prior to constructing the subbase course, the underlying course or subgrade shall be cleaned of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Ruts, or soft yielding spots, in the underlying courses, subgrade areas having inadequate compaction, and deviations of the surface from the specified requirements, shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the subbase course is placed.

## 3.4 GRADE CONTROL

The finished and completed subbase course shall conform to the lines, grades, and cross sections shown. The lines, grades, and cross sections shown shall be maintained by means of line and grade stakes placed by the Contractor at the work site.

## 3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the subbase material at the water content specified. The Contractor shall make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory subbase course.

## 3.6 LAYER THICKNESS

The compacted thickness of the completed course shall be as indicated. When a compacted layer of 150 mm is specified, the material may be placed in a single layer; when a compacted thickness of more than 150 mm is required, no layer shall exceed 150 mm nor be less than 75 mm when compacted.

## 3.7 COMPACTION

Each layer of the subbase course shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus 1 percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer is compacted through the full depth to at least 95 percent of laboratory maximum density. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory subbase course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

## 3.8 EDGES

Approved material shall be placed along the edges of the subbase course in such quantity as will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least a 300 mm width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the subbase course, as directed.

## 3.9 SMOOTHNESS TEST

The surface of each layer shall not show deviations in excess of 10 mm when tested with a 3.6 m (12 foot) straightedge applied parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by removing material, replacing with new material, or reworking existing material and compacting, as directed.

## 3.10 THICKNESS CONTROL

The completed thickness of the subbase course shall be in accordance with the thickness and grade indicated on the drawings. The thickness of each course shall be measured at intervals providing at least one measurement for each 400 square meters or part thereof of subbase course. The thickness measurement shall be made by test holes, at least 75 mm in diameter through the course. The completed subbase course shall not be more than 13 mm deficient in thickness nor more than 13 mm above or below the established grade. Where any of these tolerances are exceeded, the Contractor shall correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is 13 mm or more thicker than shown, the course will be considered as conforming with the specified thickness requirements plus 13 mm. The average job thickness shall be the average of the job measurements as specified above but within 6 mm of the thickness shown.

## 3.11 MAINTENANCE

The subbase course shall be maintained in a satisfactory condition until accepted.

-- End of Section --

SECTION 02722

AGGREGATE BASE COURSE

**AMENDMENT NO. 0001**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 29/C 29M | (1997) Bulk Density ("Unit Weight") and Voids in Aggregates |
| ASTM C 88 | (1999a) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate |
| ASTM C 117 | (1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C 127 | (1988; R 1993el) Specific Gravity and Absorption of Course Aggregate |
| ASTM C 128 | (1997) Specific Gravity and Absorption of Fine Aggregate |
| ASTM C 131 | (1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C 136 | (1996a) Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D 75 | (1987; R 1997) Sampling Aggregates |
| ASTM D 1556 | (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 1557 | (1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.)) |
| ASTM D 2487 | (2000) Classification of Soils for Engineering Purposes (Unified Soil |

| | |
|---|---|
| | Classification System) |
| ASTM D 2922 | (1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 3017 | (1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 4318 | (2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM E 11 | (1995) Wire-Cloth Sieves for Testing Purposes |

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## 1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

### 1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

### 1.2.2 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools.

List of proposed equipment to be used in performance of construction work, including descriptive data.

[AM#1] Material Source

[AM#1] Provide a list of material suppliers.

Waybills and Delivery Tickets.

Copies of waybills and delivery tickets during the progress of the work. Before the final statement is allowed, the Contractor shall file certified waybills and certified delivery tickets for all aggregates actually used.

SD-06 Test Reports

Sampling and testing.

[AM#1] Copies of the following test reports:

[AM#1] Sieve Analysis

[AM#1] Liquid Limit and Plasticity Index

[AM#1] Moisture-Density Determination

[AM#1] Density Tests

Field Density Tests.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of the tests.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

The following tests shall be performed in conformance with the applicable standards listed.

1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture content shall be determined in accordance with ASTM D 1557, Method C.

1.4.2.4 Field Density Tests

Density shall be field measured in accordance with ASTM D 1556 or ASTM D 2922. For the method presented in ASTM D 2922 the calibration curves shall be checked and adjusted if necessary using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D 2922, on each different type of material being tested at the beginning of a job and at intervals as directed.

1.4.2.5 Wear Test

Wear tests shall be made on ABC course material in conformance with ASTM C 131.

1.4.2.6 Weight of Slag

Weight per cubic meter of slag shall be determined in accordance with ASTM C 29/C 29M on the ABC course material.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis including 0.02 mm size material.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

e. Weight per cubic meter of Slag.

#### 1.4.3.2 In Place Tests

Each of the following tests shall be performed on samples taken from the placed and compacted ABC. Samples shall be taken and tested at the rates indicated.

a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 836 square meters, or portion thereof, of completed area.

b. Sieve Analysis including 0.02 mm size material shall be performed for every 2,500 square meters, or portion thereof, of material placed.

c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

d. Wear tests one per 2,500 square meters.

### 1.4.4 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted ABC.

## 1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

## 1.6 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

# PART 2 PRODUCTS

## 2.1 AGGREGATES

The ABC shall consist of clean, sound, durable particles of crushed stone, crushed gravel, angular sand, or other approved material. ABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the 4.75 mm sieve shall be known as coarse aggregate; that portion passing the 4.75 mm sieve shall be known as fine aggregate.

2.1.1 Coarse Aggregate

Coarse aggregates shall be angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.

b. Crushed Stone: Crushed stone shall consist of freshly mined quarry rock, and shall meet all the requirements specified below.

2.1.1.1 Aggregate Base Course

ABC coarse aggregate shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in TABLE 1.

2.1.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

2.1.2.1 Aggregate Base Course

ABC fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

For Texas:

Requirements for gradation specified shall apply to the completed base course. The aggregates shall be continuously graded within the following limits:

| Sieve | Percentage by Weight Passing |
|---|---|

| Designation | Square-Mesh Sieve* |
|---|---|
| 44.5 mm | 100 |
| 22.3 mm | 65 - 90 |
| 9.5 mm | 50 - 70 |
| 4.75 mm | 35 - 55 |
| 0.425 mm | 15 - 30 |

*The table is based on aggregates of uniform specific gravity and the percentages passing the various sieves are subject to appropriate corrections in accordance with ASTM C 127 and C 128 when aggregates of "varying specific gravity" are used. The gradation above conforms to Texas Department of Transportation Standard Specification for base course, Item 247, Type A, Grade 1.

### 2.1.4 Liquid Limit and Plasticity Index

Liquid limit and plasticity index requirements shall apply to the completed course and shall also apply to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the 0.425 mm sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

## PART 3 EXECUTION

### 3.1 GENERAL REQUIREMENTS

When the ABC is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

### 3.2 PREPARATION OF UNDERLYING COURSE

Prior to constructing the ABC, the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the ABC, the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 02721 SUBBASE COURSES. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the ABC. Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the ABC is placed.

## 3.3 INSTALLATION

### 3.3.1 Mixing the Materials

The coarse and fine aggregates shall be mixed in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. The Contractor shall make adjustments in mixing procedures or in equipment as directed to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory ABC meeting all requirements of this specification.

### 3.3.2 Placing

The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 150 mm or less in thickness is required, the material shall be placed in a single layer. When a compacted layer in excess of 150 mm is required, the material shall be placed in layers of equal thickness. No layer shall exceed 150 mm or less than 75mm when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the ABC is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable ABC.

### 3.3.3 Grade Control

The finished and completed ABC shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required ABC thickness so that the finished ABC with the subsequent surface course will meet the designated grades.

### 3.3.4 Edges of Base Course

The ABC shall be placed so that the completed section will be a minimum of 1.5 m wider, on all sides, than the next layer that will be placed above it. Additionally, approved fill material shall be placed along the outer edges of ABC in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 600 mm width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of ABC. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

### 3.3.5 Compaction

Each layer of the ABC shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus 1 percent of the optimum water content determined from laboratory tests as specified in paragraph SAMPLING AND TESTING. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer has a degree of compaction that is at least 100 percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory ABC. All technicians performing density testing shall be NICET Level I soil certified. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

### 3.3.6 Thickness

Compacted thickness of the aggregate course shall be as indicated. No individual layer shall exceed 150 mm nor be less than 75 mm in compacted thickness. The total compacted thickness of the ABC course shall be within 13 mm of the thickness indicated. Where the measured thickness is more than 13 mm deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm of the thickness indicated. The total thickness of the ABC course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square meters of base course. Measurements shall be made in 75 mm diameter test holes penetrating the base course.

### 3.3.7 Finishing

The surface of the top layer of ABC shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of ABC is 13 mm or more below grade, then the top layer should be scarified to a depth of at least 75 mm and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

### 3.3.8 Smoothness

The surface of the top layer shall show no deviations in excess of 10 mm when tested with a 3.05 meter straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 15 meter intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

## 3.4 TRAFFIC

Traffic shall not be allowed on the completed ABC course. Completed portions of the ABC course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

## 3.5 MAINTENANCE

The ABC shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any ABC that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of ABC that is damaged shall be reworked or replaced as necessary to comply with this specification.

## 3.6 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of as directed. No additional payments will be made for materials that must be replaced.

-- End of Section --

SECTION 02741

BITUMINOUS PAVING

**AMENDMENT NO. 0001**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 117 | (1995) Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C 127 | (1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate |
| ASTM C 128 | (1993) Specific Gravity and Absorption of Fine Aggregate |
| ASTM C 136 | (1996a) Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C 183 | (1995a) Sampling and the Amount of Testing of Hydraulic Cement |
| ASTM D 75 | (1987; R 1992) Sampling Aggregates |
| ASTM D 140 | (1998) Sampling Bituminous Materials |
| ASTM D 2041 | (1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures |
| ASTM D 2172 | (1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures |
| ASTM D 2216 | (1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock |
| ASTM D 3515 | (1996) Hot-Mixed, Hot-Laid Bituminous Paving Mixtures |

TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

STANDARD SPECIFICATIONS: (TSDHPT)

| | |
|---|---|
| TSDHPT-01 | (1993) Standard Specification for Construction of Highways, Streets and Bridges |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| COE CRD-C 649-95 | Standard Test Method for Unit Weight, Marshall Stability, and Flow of Bituminous Mixtures |
| COE CRD-C 652-92 | Standard Test Method for Measurement of Reduction in Marshall Stability of Bituminous Mixtures caused by Immersion in Water |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

[AM#1]SD-06 Product Data

Job Mix Formula (JMF).

Provide JMF for the bituminous mixture for approval by the Contracting Officer.

SD-09 Reports

Bituminous Pavement.

Copies of test results.

1.3 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.3.1 General

The bituminous plant shall be of such capacity to produce the quantities of bituminous mixtures required. Hauling equipment, paving machines, rollers, miscellaneous equipment, and tools shall be provided in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output.

1.3.2 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.66 m (12-foot) straightedge for each bituminous paver. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

## 1.4 WEATHER LIMITATIONS

Unless otherwise directed, bituminous courses shall not be constructed when temperature of the surface of the existing pavement or base course is below 5 degrees C.

## 1.5 PROTECTION OF PAVEMENT

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until the pavement has cooled to 60 degrees C.

## 1.6 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

Finished surface of bituminous courses, when tested as specified below, shall conform to gradeline and elevations shown and to surface-smoothness requirements specified.

### 1.6.1 Plan Grade

The grade of the completed surface shall not deviate more than 15.2 mm (0.05 foot) from the plan grade.

### 1.6.2 Surface Smoothness

When a 3.66 m (12-foot) straightedge is laid on the surface parallel with the centerline of the paved area or transverse from crown to pavement edge, the surface shall vary not more than 6.4 mm (1/4 inch) from the straightedge.

## 1.7 GRADE CONTROL

Lines and grades shall be established and maintained by means of line and grade stakes placed at site of work in accordance with the Special Contract Requirements. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

## 1.8 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Unless otherwise specified, sampling shall be in accordance with ASTM D 75 for aggregates, ASTM C 183 for minieral filler, and ASTM D 140 for bituminous material. Copies of test results shall be furnished to the Contracting Officer. Approval of a source does not relieve the Contractor of responsibility for delivery at the job site of materials meeting the requirements herein.

1.8.1 Tests Required

1.8.1.1 Plant Mix

a. Hot Bin Gradations: Hot Bin gradations (cold-feed gradation when drum mix plant is used) shall be tested accordance with ASTM C 136 and ASTM C 117. A minimum of one test will be conducted per every 200 tons of wearing course mix placed or fraction thereof, and a minimum of one test conducted per every 350 tons of intermediate course mix placed or fraction thereof.

b. Marshall Specimens: Marshall Specimens shall be taken in accordance with CRD-C 652-95, Method 104. At least one set of spciments shall be taken per each 200 tons of wearing course mix placed, and one set of speicmens shall be taken per each 350 tons on intermediate course mix placed. However, not less than two sets of specimens (three specimens per set) shall be taken in any one day regardless of the quantity of mix placed.

c. Asphalt Extractions: Asphalt extractions shall be performed in accordance with ASTM D 2172, Method A or B. At least one asphalt extraction shall be conducted per day.

1.8.1.2 Field Density Tests

Field Density Tests shall be conducted in accordance with CRD-C 650-95, Method 100. A minimum of one test will be conducted per every 200 tons of wearing course mix placed or fraction thereof, and a minimum of one test conducted per every 350 tons of intermediate course mix placed or fraction thereof.

1.8.1.3 Thickness Measurement

Thickness Measurements shall be taken at a minimum of one measurement for each 835 square meter of mix placed.

1.9 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.9.1 Mineral Aggregates

Mineral aggregates shall be delivered to the site of the bituminous mixing plant and stockpiled in such manner as to preclude fracturing of aggregate particles, segregation, contamination, or intermingling of different materials in the stockpiles or cold-feed hoppers. Mineral filler shall be delivered, stored, and introduced into the mixing plant in a manner to preclude exposure to moisture or other detrimental conditions.

1.9.2 Bituminous Materials

Bituminous materials shall be maintained at appropriate temperature during storage but shall not be heated by application of direct flame to walls of storage tanks or transfer lines. Storage tanks, transfer lines, and weigh buckets shall be thoroughly cleaned before a different type or grade of bitumen is introduced into the system. The asphalt cement shall be heated sufficiently to allow satisfactory pumping of the material; however, the storage temperature shall be maintained below 150 degrees C.

## 1.10 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the paving plant for checking adequacy of the equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

# PART 2 PRODUCTS

## 2.1 HOT-MIX SURFACE COURSE

Bituminous hot-mix surface course shall conform to the requirements of TSDHPT-01 for "Hot-Mix Asphaltic Concrete Pavement," Item 340, except as specified hereinafter.

### 2.1.1 Asphalt Material

Asphalt material for the surface course shall be asphalt cement AC-20 conforming to TSDHPT-01 for "Asphalts, Oils, and Emulsions," Item 300. Asphalt material shall come from a source approved for use by the TSDHPT. The seal number from the tank and the number of the TSDHPT Laboratory test report shall be furnished tothe Contracting Officer.

### 2.1.2 Paving Mixture

Paving mixture shall be Type "D".

### 2.1.3 State Specification Modifications

TSDHPT Specification shall be modified as follows:

a. Material retained on the 2 mm size sieve shall not exceed 65 percent.

b. Density and stability requirements shall not apply.

c. Construction methods paragraph shall not apply.

d. The measurement and payment paragraph shall not apply.

## 2.2 PROPORTIONING OF MIXTURE

### 2.2.1 Job Mix Formula (JMF)

The JMF for the bituminous mixture shall be furnished to the Contracting Officer for approval. No payment will be made for mixtures produced prior to the approval of the JMF. The formula will indicate the percentage of each stockpile and mineral filler, the percentage of each size aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. The tolerances specified in TSDHPT-01, Item 340, will be allowed for asphalt content, temperature, and aggregate grading for tests conducted on the mix as discharged from the mixing plant. Bituminous mix that deviates more than 14 degrees C from the JMF shall be rejected. The JMF may be adjusted during construction to improve paving mixtures, as directed, without adjustments in the contract unit prices.

2.2.2 Test Properties of Bituminous Mixtures

Finished mixture shall meet requirements described below when tested in accordance with COE CRD-C 649-95. All samples will be compacted with 50 blows of specified hammer on each side of sample. When bituminous mixture fails to meet the requirements specified below, the paving operation shall be stopped until the cause of noncompliance is determined and corrected.

2.2.2.1 Stability, Flow, and Voids

Requirements for stability, flow, and voids are shown in TABLES I and II for nonabsorptive and absorptive aggregates, respectively.

TABLE I. NONABSORPTIVE-AGGREGATE MIXTURE

| | Wearing Course | Intermediate Course |
|---|---|---|
| Stability minimum, newtons | 2200 | 2200 |
| Flow maximum, 25/100-millimeter units | 20 | 20 |
| Voids total mix, percent (1) | 3-5 | 4-6 |
| Voids filled with bitumen, percent (2) | 75-85 | 65-75 |

(1) The Contracting Officer may permit deviations from limits specified when gyratory method of design is used to develop the JMF.

(2) The Contracting Officer may permit deviation from limits specified for voids filled with bitumen in the intermediate course in order to stay within limits for percent voids total mix.

TABLE II. ABSORPTIVE-AGGREGATE MIXTURE

| | Wearing Course | Intermediate Course |
|---|---|---|
| Stability minimum, newtons | 2200 | 2200 |
| Flow maximum, 25/100-millimeter units | 20 | 20 |
| Voids total mix, percent (1) | 2-4 | 3-5 |
| Voids filled with bitumen, percent (2) | 80-90 | 70-80 |

(1) The Contracting Officer may permit deviations from limits specified when gyratory method of design is used to develop the JMF.

(2) The Contracting Officer may permit deviation from limits specified for voids filled with bitumen in the intermediate course in order to stay within limits for percent voids total mix.

a. When the water-absorption value of the entire blend of aggregate does not exceed 2.5 percent as determined in accordance with ASTM C 127and ASTM C 128, the aggregate is designated as nonabsorptive. The theoretical specific gravity computed from the apparent specific gravity or ASTM D 2041 will be used in computing voids total mix and voids filled with bitumen, and the mixture shall meet requirements in TABLE I.

b. When the water-absorption value of the entire blend of aggregate exceeds 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive. The theoretical specific gravity computed from ASTM D 2041 shall be used in computing percentages of voids total mix and voids filled with bitumen; the mixture shall meet requirements in TABLE II.

2.2.2.2 Stability

The index of retained stability must be greater than 75 percent as determined by COE CRD-C 652-95. When the index of retained stability is less than 75, the aggregate stripping tendencies may be countered by the use of hydrated lime or by treating the bitumen with an approved antistripping agent. The hydrated lime is considered as mineral filler and should be considered in the gradation requirements. The amount of hydrated lime or antistripping agent added to bitumen shall be sufficient, as approved, to produce an index of retained stability of not less than 75 percent. No additional payment will be made to the Contractor for addition of antistripping agent required.

PART 3 EXECUTION

3.1 BASE COURSE CONDITIONING

The surface of the base course will be inspected for adequate compaction and surface tolerances specified in Section 02722 AGGREGATE BASE COURSE. Unsatisfactory areas shall be corrected.

3.2 PREPARATION OF BITUMINOUS MIXTURES

Rates of feed of aggregates shall be regulated so that the moisture content and temperature of aggregates will be within specified tolerances. Aggregates, mineral filler, and bitumen shall be conveyed into the mixer in proportionate quantities required to meet the JMF. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing shall not exceed 150 degrees C. Temperature of aggregate and mineral filler in the mixer shall not exceed 160 degrees C when bitumen is added. Overheated and carbonized mixtures or mixtures that foam shall not be used.

3.3 WATER CONTENT OF AGGREGATES

Drying operations shall reduce the water content of mixture to less than

0.75 percent. The water content test will be conducted in accordance with ASTM D 2216; the weight of the sample shall be at least 500 grams. If the water content is determined on hot bin samples, the water content will be a weighted average based on composition of blend.

## 3.4 STORAGE OF BITUMINOUS PAVING MIXTURE

Storage shall conform to the applicable requirements of ASTM D 3515; however, in no case shall the mixture be stored for more than 4 hours.

## 3.5 TRANSPORTATION OF BITUMINOUS MIXTURE

Transportation from paving plant to site shall be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the mixture to the truck bodies. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect mixture from weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or that have become wet will be rejected. Hauling over freshly placed material will not be permitted.

## 3.6 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of the intermediate or wearing course, the underlying course shall be cleaned of all foreign or objectionable matter with power brooms and hand brooms.

## 3.7 PRIME COATING

Surfaces of previously constructed base course shall be sprayed with a coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

## 3.8 TACK COATING

Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

## 3.9 PLACING

Bituminous courses shall be constructed only when the base course or existing pavement has no free water on the surface. Bituminous mixtures shall not be placed without ample time to complete spreading and rolling during daylight hours, unless approved satisfactory artificial lighting is provided.

### 3.9.1 Offsetting Joints

The wearing course shall be placed so that longitudinal joints of the wearing course will be offset from joints in the intermediate course by at least 300 mm. Transverse joints in the wearing course shall be offset by at least 600 mm from transverse joints in the intermediate course.

3.9.2 General Requirements for Use of Mechanical Spreader

Range of temperatures of mixtures, when dumped into the mechanical spreader, shall be as determined by the Contracting Officer. Mixtures having temperatures less than 110 degrees C when dumped into the mechanical spreader shall not be used. The mechanical spreader shall be adjusted and the speed regulated so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface will conform to the cross section indicated. Placing with respect to center line areas with crowned sections or high side of areas with one-way slope shall be as directed. Each lot of material placed shall conform to requirements specified in paragraph ACCEPTABILITY OF WORK. Placing of the mixture shall be as nearly continuous as possible, and speed of placing shall be adjusted, as directed, to permit proper rolling. When segregation occurs in the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected.

3.9.3 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after initial strip has been spread and compacted as specified below, the screed of the mechanical spreader shall overlap the previously placed strip 50 to 75 mm and be sufficiently high so that compaction produces a smooth dense joint. Mixture placed on the edge of a previously placed strip by the mechanical spreader shall be pushed back to the edge of the strip by use of a lute. Excess mixture shall be removed and wasted.

3.9.4 Handspreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent segregation. The mixture shall be spread uniformly with hot rakes in a loose layer of thickness that, when compacted, will conform to required grade, density, and thickness.

3.10 COMPACTION OF MIXTURE

Rolling shall begin as soon after placing as the mixture will bear a roller without undue displacement. Delays in rolling freshly spread mixture will not be permitted. After initial rolling, preliminary tests of crown, grade, and smoothness shall be made by the Contractor. Deficiencies shall be corrected so that the finished course will conform to requirements for grade and smoothness specified herein. Crown, grade, and smoothness will be checked in each lot of completed pavement by the Contracting Officer for compliance [AM#1] <u>and will be evaluated as specified in paragraph ACCEPTABLILITY OF WORK</u>. After the Contractor is assured of meeting crown, grade, and smoothness requirements, rolling shall be continued until a mat density of 97.0 to 100.0 percent and a joint density of 95.0 to 100.0 percent of density of laboratory-compacted specimens of the same mixture is obtained. [AM#1] <u>The density will be determined and evaluated as specified in paragraph ACCEPTABILITY OF WORK.</u> Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.

3.10.1 Correcting Deficient Areas

Mixtures that become contaminated or are defective shall be removed to the full thickness of the course. Edges of the area to be removed shall be cut so that sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be sprayed with bituminous materials conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS. Fresh paving mixture shall be placed in the excavated areas in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. Paving mixture shall be compacted to the density specified herein. Skin patching of an area that has been rolled shall not be permitted.

3.11 JOINTS

3.11.1 General

Joints between old and new pavements, between successive work days, or joints that have become cold (less than 80 degrees C) shall be made to ensure continuous bond between the old and new sections of the course. All joints shall have the same texture and smoothness as other sections of the course. Contact surfaces of previously constructed pavements coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back as directed. When directed by the Contracting Officer, the surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS. Material shall be applied far enough in advance of placement of a fresh mixture to ensure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

3.11.2 Transverse Joints

The roller shall pass over the unprotected end of a strip of freshly placed material only when placing is discontinued or delivery of the mixture is interrupted to the extent that the material in place may become cold. In all cases, prior to continuing placement, the edge of previously placed pavement shall be cut back to expose an even vertical surface for full thickness of the course. In continuing placement of a strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.11.3 Longitudinal Joints

Edges of a previously placed strip shall be prepared such that the pavement in and immediately adjacent to the joint between this strip and the succeeding strip meets the requirements for grade, smoothness, and density specified.

[AM#1]3.12 ACCEPTABILITY OF WORK

[AM#1]3.12.1 Density

The average mat and joint densities will be expressed as a percentage of the laboratory density.

[AM#1]3.12.2 Field Density

The field density will be determined and compared with TABLE III. The percent payment based on density shall be the lowest value determined from TABLE III. The percent payment based on mat density will be for all of the material placed in the lot. The percent payment based on joint density will be for the amount of material represented by an area equal to the lot joint length by 3 m wide not to exceed the lot size.

TABLE III. PERCENT PAYMENT BASED ON DENSITY

| Average Mat Density (4 Cores) | Percent Payment | Average Joint Density (4 Cores) |
|---|---|---|
| 97.0-100.0 | 100.0 | 95.0-100.0 |
| 96.9 | 100.0 | 94.9 |
| 96.8-100.1 | 99.9 | 94.8 |
| 96.7 | 99.8 | 94.7 |
| 96.6-100.2 | 99.6 | 94.6 |
| 96.5 | 99.4 | 94.5 |
| 96.4-100.3 | 99.1 | 94.4 |
| 96.3 | 98.7 | 94.3 |
| 96.2-100.4 | 98.3 | 94.2 |
| 96.1 | 97.8 | 94.1 |
| 96.0-100.5 | 97.3 | 94.0 |
| 95.9 | 96.3 | 93.9 |
| 95.8-100.6 | 94.1 | 93.8 |
| 95.7 | 92.2 | 93.7 |
| 95.6-100.7 | 90.3 | 93.6 |
| 95.5 | 87.9 | 93.5 |
| 95.4-100.8 | 85.7 | 93.4 |
| 95.3 | 83.3 | 93.3 |
| 95.2-100.9 | 80.6 | 93.2 |
| 95.1 | 78.0 | 93.1 |
| 95.0-101.0 | 75.0 | 93.0 |
| below 95.0, above 101.0 | reject | below 93.0 |

-- End of Section --

SECTION 02763

PAVEMENT MARKINGS

**AMENDMENT NO. 0001**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS TT-P-1952 | (Rev D; Canc. Notice 1) Paint, Traffic and Airfield Marking, Waterborne (Metric) |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment; G.

Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation.

Composition Requirements.

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

Qualifications.

Document certifying that personnel are qualified for equipment operation and handling of chemicals.

SD-06 Test Reports

Sampling and Testing.

Certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

[AM#1] __________________

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____________________

1.3 DELIVERY AND STORAGE

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.4 EQUIPMENT

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.4.1 Paint Application Equipment

The equipment to apply paint to pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. The machine shall have a speed during application not less than 8 kilometers per hour (5 mph), and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified in paragraph APPLICATION, and of even uniform thickness with clear-cut edges. Equipment used for marking streets and highways shall be capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines or a combination of solid and intermittent lines using a maximum of two different colors of paint as specified. The paint applicator shall have paint reservoirs or tanks of sufficient capacity and suitable gauges to apply paint in accordance with requirements specified. Tanks shall be equipped with suitable air-driven mechanical agitators. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gauges in full view and reach of the operator. Paint strainers shall be installed in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. Pneumatic spray guns shall be provided for hand application of paint in areas where the mobile paint applicator cannot be used.

1.4.2 Surface Preparation Equipment

1.4.2.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 70.8 liters per sec (150 cfm) of air at a pressure of not less than 620 kPa (90 psi) at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.4.2.2 Waterblast Equipment

The water pressure shall be specified at 17.9 MPa (2600 psi) at 60 degrees C (140 degrees F) in order to adequately clean the surfaces to be marked.

1.4.3 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.4.3.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.4.4 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.5 HAND-OPERATED, PUSH-TYPE MACHINES

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

1.6 MAINTENANCE OF TRAFFIC

1.6.1 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe passage of vehicles shall be provided.

## 1.7 WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 5 degrees C and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

# PART 2 PRODUCTS

## 2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints for roads, and streets shall conform to FS TT-P-1952, color as indicated. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

## 2.2 SAMPLING AND TESTING

Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers by the Contractor in the presence of a representative of the Contracting Officer. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application.

# PART 3 EXECUTION

## 3.1 SURFACE PREPARATION

Surfaces to be marked shall be thoroughly cleaned before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

### 3.1.1 Cleaning Existing Pavement Markings

In general, markings shall not be placed over existing pavement marking patterns. Existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns, shall be removed. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

## 3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

### 3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 5 degrees C and less than 35 degrees C. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified . The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

#### 3.2.1.1 Rate of Application

a. Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 2.9 plus or minus 0.5 square meter per liter.

#### 3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

### 3.2.2 Thermoplastic Compounds

Thermoplastic pavement markings shall be placed upon dry pavement; surface dry only will not be considered an acceptable condition. At the time of installation, the pavement surface temperature shall be a minimum of 5 degrees C and rising. Thermoplastics, as placed, shall be free from dirt or tint.

3.2.2.1 Longitudinal Markings

All centerline, skipline, edgeline, and other longitudinal type markings shall be applied with a mobile applicator. All special markings, crosswalks, stop bars, legends, arrows, and similar patterns shall be placed with a portable applicator, using the extrusion method.

-- End of Section --

# SECTION 02925

# ESTABLISHMENT OF TURF
**9/2000**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS (AOAC)

| | |
|---|---|
| AOAC-01 | Official Methods of Analysis |

COMMERCIAL ITEM DESCRIPTIONS (CID)

| | |
|---|---|
| CID A-A-1909 | (Basic; Notice 1; Canc. Notice 2) Fertilizer |

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Notification of Sources; G,{AM#0001} ED.

The Contractor shall notify the Contracting Officer for approval, in writing, the sources from which the following materials will be furnished:

Sod

Construction Equipment List; G,{AM#0001} ED.

Prior to planting operations, the Contractor shall furnish for approval, notification of the types of equipment, including descriptive data, the Contractor proposes to use in turfing operations such as preparation of ground surface, sod-cutting, seeding, mowing, and watering.

SD-06 Test Reports

Soil; G, {AM#0001}___ED.

Fertilizer; G,{AM#0001}__ED.

Seed ;G,{AM#0001}__ED.

Test reports of samples of fertilizer and seed shall be signed and certified by the testing laboratory. Testing laboratories used by the Contractor shall be approved by the Contracting Officer.

SD-07 Certificates

Fertilizer{AM#0001}_______________.

Bulk deliveries of fertilizer shall be accompanied by a certificate indicating net pounds furnished, chemical analysis, name, trade name, and warranty of the supplier of the fertilizer.

Seed{AM#0001}___________.

The Contracting Officer shall be furnished signed copies of certificates from the seed vendor, certifying that each container of seed delivered is labeled in accordance with Federal Seed Act and is at least equal to requirements specified. This certification shall be obtained from the vendor and shall be furnished on or with all copies of seed invoices.

SD-07 Certificates

Signed, certified copies of the following reports shall be submitted:

Fertilizer{AM#0001}_________.

Invoices obtained from the vendor shall indicate quantities and grade of each fertilizer furnished.

Seed{AM#0001}______________.

Invoices shall be obtained from the vendor.

Official Seed Analysis or Official Seed Tags{AM#0001}_________.

Obtained from the vendor. The official seed analysis or the official seed tags shall be furnished with all copies of the seed invoices.

## 1.3 INSPECTION AND TESTS

### 1.3.1 Soil

Obtain no fewer than four samples of top soil to be tested. Submit samples to testing laboratory. Laboratory to test soil for: General texture classification, percent organic material, PH, conductivity (soluble salts), calcium, phosphorous, potassium, nitrogen, magnesium, zinc, and iron. Obtain and submit written Lab Report with recommendations of Botanist for soil ammending, and fertilizing for planning materials specified.

### 1.3.2 Fertilizer

Samples of each lot of fertilizer shall be tested by the Contractor upon request of the Contracting Officer. Sampling and testing shall be in accordance with the AOAC-01 Official Methods of Analysis, at the discretion of Contracting Officer. The empty fertilizer bags shall be retained, and upon completion of the project, a final check of total quantities of fertilizer used will be made against the total area treated. If minimum rates of application have not been met, additional quantities of these materials shall be distributed as directed to make up minimum application specified.

### 1.3.3 Seed

Each lot of seed may be sampled and tested in accordance with latest USDA Rules and Regulations under the Federal Seed Act at the discretion of the Contracting Officer. Such sampling and testing shall be made by or under the supervision of the Government. If these tests reveal the seed to be below the specified pure live seed content, the Contractor shall be required to plant additional seed to compensate for the deficiency at no additional cost to the Government. The seed test will be conducted by the State Seed Laboratory.

### 1.3.4 Sod

Not less than five days prior to commencement of sodding operations, the Contracting Officer shall be notified of the off-site sources from which sod is to be furnished. Sod shall be inspected prior to and during laying operations; sod that fails to meet requirements shall be rejected. Rejected material, if suitable, may be pulverized and used for filling. The average thickness of the sod will be determined at the sodding site as follows: 11 random sods will be stacked on a flat surface; the thickness from the base of the bottom sod to the base of the top sod will be measured, and that thickness divided by 10.

### 1.3.5 Mulch

Not less than five days prior to commencement of mulching operations the Contracting Officer shall be notified of sources from which mulch materials are available and the quantities thereof. Representative samples of the material proposed for use shall be submitted for approval. A weight certificate signed by a public weigher shall be furnished for each load of mulch used on the site. The weight certificates shall be furnished prior to applying the mulch. The mulch material shall be unloaded and stacked in an orderly manner.

## 1.4 PAYMENT

No payment or partial payment will be made for work covered by this section of the specifications until all portions of this section, including maintenance of turfing work, are adequately performed and accepted, as determined by the Contracting Officer.

## 1.5 DELIVERY AND STORAGE

### 1.5.1 Delivery

#### 1.5.1.1 Fertilizer

Fertilizer shall be delivered to the site in original, unopened bags or other convenient containers, each fully labeled, conforming to the applicable State fertilizer laws, and bearing the name, trade name or trademark, and warranty of the producer. In lieu of bags or containers, fertilizer may be furnished in bulk. Bulk deliveries shall be accompanied by a certificate conforming to paragraph 1.3 SUBMITTALS, SD-13 Certificates.

#### 1.5.1.2 Seed

Seed shall be furnished in sealed, standard containers unless written exception is granted.

### 1.5.2 Storage

#### 1.5.2.1 Storage Area

Materials shall be stored in areas designated by the Contracting Officer.

#### 1.5.2.2 Seed and Fertilizer

Seed and fertilizer shall be stored in dry locations away from contaminants.

#### 1.5.2.3 Sod

Sod shall be lightly sprinkled with water, covered with moist burlap, straw or other covering; and protected from exposure to wind and direct sunlight until planted. Covering shall be provided that will allow air to circulate and prevent internal heat from building up.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Fertilizer for Fertilizing

Fertilizer shall be commercial grade, free flowing, uniform in composition and conforming to CID A-A-1909. Granular Fertilizer: As recommended by the soil test.

### 2.1.2 Fertilizer for Refertilizing

Fertilizer for refertilizing shall be ammonium sulphate containing 21 percent nitrogen or ammonium nitrate containing 33 percent nitrogen, uniform in composition, free flowing, and suitable for application with approved equipment.

2.1.3 Organic Material

Decomposed organic material such as well-aged cow manure, sphagnum peat, compost, or humus, elastic and homogeneous; free of decomposed colloidal residue, wood or trash; ph between 5.9 and 7.0; minimum 60 percent organic matter by weight; salt;t content less than 2 MMHO/CM; maximum 15 percent moisture content.

2.1.4 Seed

Seed labeled in accordance with USDA Rules and Regulations under the Federal Seed Act shall be furnished. Seed that is wet or moldy or that has been otherwise damaged in transit or storage will not be acceptable. The seed shall be free of field bindweed, hedgeweed, and nutgrass seed. Seed shall not contain other noxious weed seed in excess of the limits allowable under the Federal Seed Act and applicable State seed laws. Seed labeled as mixture or pasture mixture will not be acceptable. Common Bermudagrass seed shall not contain in excess of 3 percent of giant strains of Bermudagrass. Each seed container shall bear the date of the last germination which date shall be within a period of six months prior to commencement of planting operations.

2.1.4.1 Seed Mixture

Seed with the following percentage by weight of pure live seed in each lot shall be furnished. Weed seed shall not exceed one percent.

| | Irrigated Seed | | Percent of Pure | Hulled |
|---|---|---|---|---|
| or | Common Name | Scientific Name | Live Seed | Unhulled |
| | Common Bermudagrass | Cynodon dactylon | 82 | Hulled |

| Non-Irrigated Seed | | Percent of Pure | Hulled or |
|---|---|---|---|
| Common Name | Scientific Name | Live Seed | Unhulled |
| Buffalo Grass | Buchloe dactyloides "Texoka" | 75 | Hulled-soak & chill treated |
| Bermudagrass | Cynodon Dactylon | 82 | Hulled |

NOTE:

$$\frac{\text{\% Purity times (\% Germination plus \% hard or dormant seed)}}{100} = \text{\%pure live seed}$$

2.1.5 Sod

Sod containing a dense cover of growing or living grass shall be provided. Living grass is defined as grass that is seasonably dormant during a cold or dry season and capable of renewing growth after the dormant period. At least 90 percent of the plants in the sod shall be Common Bermudagrass. Sod shall be procured from areas having growing conditions similar to those areas on which the sod is to be used. Sod shall be furnished that is free of noxious weeds and undesirable plants, stones, roots of trees, and other materials that hinder the development and maintenance of sod. Vegetation more than three inches in height shall be cut to two inches or less, and hay and other loose materials on the surface shall be removed at least 5 days before the sod is lifted. Sod shall be procured from areas containing clay or clay loam topsoil. Sod shall have such density that when it is cut in strips one foot wide, it can be lifted and handled without breaking. When the sod is cut, the height of the grass shall not exceed two inches. Sod shall be cut with an approved sod cutter to provide an average thickness of 38 mm . All sod shall be furnished by the Contractor from approved sources off the site.

#### 2.1.6 Water

Water shall be free from oil, acid, alkali, salt, and other substances harmful to growth of grass, and shall be from a source approved prior to use.

#### 2.1.7 Mulch

Acceptable mulch shall be baled, bright, native prairie hay, such as broomsedge bluestem, little bluestem, big bluestem, switchgrass, and indiangrass, or hay of other grasses and sedges having the equivalent in leafiness, structure and fibre strength. Bermudagrass hay, cereal grain straw (such as oat and wheat), and forage sorghums, including Johnson grass, will not be accepted. Hay material which has passed through a seed harvesting combine or a thresher will not be acceptable. A minimum of 50 percent of weight of the herbage making up the material shall be 250 mm in length or longer. Mulch material which contains an excessive quantity of mature seed of noxious weeds or other species, including crops which would be detrimental to the grasses planted on the mulched areas or provide a menace to surrounding farm lands, will not be acceptable. Discolored, weathered, brittle hay or any hay harvested during the dormant season will not be acceptable.

## PART 3 EXECUTION

### 3.1 GENERAL

The turfing work shall be accomplished only when satisfactory results can be expected. When conditions such as drought, excessive moisture, high winds, or other factors prevail to such an extent that satisfactory results are not likely to be obtained the Contracting Officer may, at his own discretion, stop any phase of the work. The work shall be resumed only when, in the opinion of the Contracting Officer, the desired results are likely to be obtained. All turfing operations shall be conducted across the slope. Establishment of turf shall be accomplished on all unpaved graded and disturbed areas that are the result of the Contractor's operations. Hydromulching will not be accepted.

### 3.2 PLANTING SEASON

The planting season for spring turfing work shall be from 1 April to 1 June ; planting shall be accomplished during the first planting season, or portion thereof (but not less than 15 days), following substantial completion of building construction.

## 3.3 SEQUENCE OF TURFING

Turfing operations shall be performed in the following sequence; fertilize, prepare ground surface, spot-sod Common Bermudagrass, over-seed with Common Bermudagrass, water, mow and refertilize.

## 3.4 MULCHING

The mulching work shall be accomplished only when satisfactory results can be expected. When conditions such as drought, excessive moisture, high winds, or other factors prevail to such an extent that satisfactory results are not likely to be obtained the Contracting Officer may, at his own discretion, stop any phase of the work. The work shall be resumed only when, in the opinion of the Contracting Officer, the desired results are likely to be obtained. All mulching operations shall be conducted across the slope. Mulching shall be accomplished as indicated on the drawings and as specified herein.

## 3.5 MULCHING PRIOR TO PLANTING

During periods when turfing is not approved in PART 3 paragraph PLANTING SEASON, hay mulch shall be applied at the rate of 3 metric tons per hectare following liming and tilling. Hay mulch will then be anchored.

## 3.6 APPLICATION OF FERTILIZER

Fertilizer shall be applied not more than 24 hours in advance of tilling operations. The fertilizer distributor box shall be equipped with baffle plates to prevent downward movement of fertilizer when operating on the slope. Fertilizer shall be distributed with a fertilizer distributor (Ezee Flow) or approved equal. Fertilizer shall be uniformly distributed at the rate recommended by the soil report. As a basis of bid, use a rate of 560 kg of 16-20-0 or equal per hectare prior to tilling.

### 3.6.1 Refertilizing

The planted areas shall be refertilized 5 weeks after commencement of maintenance operations, with refertilizing completed not later than 3 days after commencement. Fertilizer shall be applied at the rate of 159 kg of ammonium sulphate or of ammonium nitrate per hectare using a fertilizer distributor (Ezee Flow or approved equal). Fertilizer shall be applied when the vegetation is dry. The refertilized areas shall be watered as specified for MAINTENANCE OF TURFING WORK within 24 hours following refertilizing operations.

## 3.7 MULCHING

### 3.7.1 Applying Mulch

Mulch shall be spread uniformly in a continuous blanket, using 7.8 metric tons per hectare . Mulch shall be spread by hand or by an approved blower-type mulch spreader. Blower-type mulch spreaders shall be adjusted and operated in such manner to prevent excessive breakage of the mulch material. If this cannot be accomplished, the mulch shall be spread by hand. Care shall be exercised to insure that all wire from baled hay is collected as it is removed from the bale and then removed from the site. Mulching shall be started at the windward side of relatively flat areas, or at the upper part of a steep slope, and continued uniformly until the area is covered. The mulch shall not be bunched.

3.7.1.1 Mulching Prior to Planting

During periods when turfing not approved in PART 3 paragraph PLANTING SEASON, hay mulch shall be applied at the rate of 7.8 metric tons per hectare following fertilizing and tilling. Hay mulch will then be anchored.

3.7.2 Anchoring Mulch

Immediately following spreading, the mulch shall be anchored in the soil to a depth of 50 mm to 76 mm . An approved machine equal to a disk harrow with cupped disks removed and replaced with straight rolling coulters spaced not more than 203 mm apart and having edges approximately 3.2 mm wide shall be used to anchor the mulch. The machine shall be weighted and operated in such manner to secure the hay firmly in the ground to form a soil-binding mulch and prevent loss or bunching of the hay by wind. The mulch anchoring machine shall be as manufactured by the Finn Equipment Co. of Cincinnati, Ohio, or approved equal. The mulch machine shall be anchored as required to prevent downward movement of the equipment and the formation of ridges and ruts. Suitable anchoring equipment shall be on hand and ready for use prior to applying the mulch. The coulters shall be at least 10 inches in diameter. Mulch shall be secured within 24 hours after spreading of mulch. The number of passes needed, not to exceed three, will be determined by the Contracting Officer.

3.7.3 Maintenance of Mulched Areas

Mulch shall be maintained until Commencement of turfing operations, then mulch shall be incorporated into the topsoil during preparation of ground surface for planting operations. Maintenance shall consist of providing protection against traffic by erecting barricades and placing warning signs. Damage shall be repaired, and mulch material that has been removed by wind or other causes shall be replaced and secured.

3.8 PREPARATION OF GROUND SURFACE

3.8.1 General

Equipment, in good condition, shall be provided for the proper preparation of the ground. Equipment shall be subject to approval before work is started.

3.8.2 Clearing

Prior to grading and tilling, vegetation that may interfere with operations shall be mowed, grubbed, and raked. The collected material shall be removed from the site. The surface shall be cleared of stumps, and stones larger than 25 mm in diameter, and roots, cable, wire, and other materials that might hinder the work or subsequent maintenance shall also be removed.

3.8.3 Grading

Previously established grades shall be maintained on the areas to be treated in a true and even condition, and necessary repairs shall be made to previously graded areas. All surfaces shall be left in a smooth condition to prevent formation of depressions. Areas having inadequate drainage as indicated by the ponding of water near foundations, walks, driveways, or on other areas shall be filled or graded to drain as directed by the Contracting Officer. Ruts, deep tracks, dead furrows, and ridges shall be eliminated and the necessary replanting accomplished prior to acceptance of the completed work. The finished grade shall be such that after the various turfing operations, the planted grade will be 25 mm below the adjacent surfaced grade of walks, drives, and curbs.

3.8.4 Soil Amendment Applications

Spread 20 mm thickness organic material, amendments, and fertilizers recommended by soil report over ground surface. As a basis for bid, apply 25 gm Diamonium Phosphate and 3 gm iron sulfate per square meter.

3.8.5 Tillage

After the areas have been brought to the grades shown and soil ammendments applied, tillage shall be accomplished in such manner as to destroy existing vegetation, to thoroughly mix ammendments and to prepare an acceptable seed bed. The Contractor shall utilize tractors with adequate horsepower and heavy duty tillage equipment in accomplishing the specified tillage operations. All areas shall be tilled with a heavy duty disk or chisel type breaking plow followed by disking with a disk harrow, and smoothing with a weighted spike tooth harrow, railroad irons, or bridge timber float drag. When a chisel plow is used the chisels shall be set not to exceed 250 mm apart, and the areas shall be cross or double tilled. Lawn areas shall be left smooth for lawn purposes and other areas shall be left smooth for ease of mowing. Depth of tillage shall be 100 mm .

3.9 SODDING

3.9.1 Obtaining and Handling Sod

After inspection and approval of the source of sod, the sod shall be cut into squares or rectangular sections, exercising care to retain the native soil on the roots of the sod during stripping, transporting, and planting.

Sod shall be transplanted within 24 hours after the sod is stripped, unless stored in a satisfactory manner. If sod is stacked it shall be placed roots to roots or grass to grass. Sod shall be kept moist during delivery and while in stacks. Sod shall be protected from exposure to wind and sun and from freezing. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected.

Rectangular sections of sod may vary in length but shall be of equal width and of a size that permits the sod to be lifted and rolled without breaking. Sod shall not be dumped from vehicles. When soil is too dry, permission to cut sod will be granted only after the ground has been watered sufficiently to moisten the ground to the depth to which sod is to be cut. Damaged sod will be rejected. The sod shall be cut with an approved sod cutter.

3.9.2 Placing Sod

When authorized in writing, sodding may be performed during dry weather or periods of drought, provided the ground is watered sufficiently to moisten the soil adequately to the depth to which sod is to be cut and provided the area to be sodded is thoroughly watered to a depth of at least 100 mm prior to placing sod.

3.9.2.1 Spot Sodding

Sod shall be cut into blocks at least 100 mm square. The individual pieces of sod shall be placed in a staggered formation in 460 mm rows on 460 mm centers with the turf side up. The sod shall be placed in holes or furrows which have been opened to a depth comparable to the thickness of the sod. The sod shall be pressed firmly into the soil with foot pressure or by tamping. The soil shall be filled in around the sides of the sod by hand raking, leaving a smooth surface free of undulations. In no case shall the top of the planted sod be covered with soil except on the extreme outer edges. Within 8 hours after commencement of the planting of the sod, the planted area shall be compacted with one or more passes of a smooth surface steel roller or with a Brillion seeder, weighing 72 kg to 86 kg per linear meter .

3.10 PLANTING SEED

The Contractor shall conduct seeding equipment calibration tests in the presence of the Contracting Officer as a means of determining the equipment setting to plant the seed at the specified rates. If unplanted skips and areas are noted after germination and growth of the grass, the Contractor shall be required to seed the unplanted areas with the grass or grasses that were to have been planted at no additional cost to the Government. Seed boxes shall be kept at least half full during seeding operations to insure even distribution of seed over all the areas seeded. Seeding equipment operating on slopes shall be anchored, as required, to prevent downward movement of the equipment and formation of ridges and ruts.

3.10.1 Seeding

The equipment to be used and the methods of planting shall be subject to the inspection and approval of the Contracting Officer prior to commencement of planting operations. Irrigated Seed shall be planted at the rate of 50 kg of Common Bermudagrass per hectare. Non-irrigates seed shall be planted at a rate of 25 kg Common Bermudagrass per hectare. The seed shall be planted using a Brillion seeder or approved equal. Depth of planting the seed shall be 13 mm to 19 mm . The seed shall be planted after spot sodding and prior to the initial watering.

#### 3.10.2 Protection

Immediately after seeding is completed on an area, the seeded area shall be protected against traffic or other use by erecting barricades and by placing warning signs of a type approved by the Contracting Officer. Such protective devices shall be maintained until completion of all work under this contract.

### 3.11 INITIAL WATERING

Water shall be applied to the spot sodded areas after compacting and seeding. Such watering shall be within 12 hours after commencement of spot sodding operations on each portion of an area to be planted. If the soil is extremely dry prior to planting, watering of the areas 48 to 72 hours in advance of planting may be required, if deemed necessary by the Contracting Officer. Water shall be applied using portable aluminum pipelines with rotating sprinklers. The sprinklers shall not be spaced in excess of 12meters apart. Small areas which are inaccessible with portable aluminum pipelines will be watered with hoses and rotating sprinklers. Water shall be applied to the planted areas at a rate sufficient to insure thorough wetting of the soil to a depth of 100 mm over the entire planted area which will usually require a minimum of 102,200 liters per hectare . The actual rate will be determined by the Contracting Officer at the time of watering. Watering operations shall be discontinued during and following effective rains and resumed as directed by the Contracting Officer. Watering operations shall be properly supervised to prevent run-off of water. The Contractor shall supply all pumps, hoses, pipelines and sprinkling equipment. The Contractor shall have adequate equipment available for watering operations prior to commencement of planting operations. The Contractor shall repair areas damaged by watering operations at no cost to the Government. All water shall be kept free from oil, acids, alkali, salts, and other substances harmful to the growth of grass.

### 3.12 MAINTENANCE OF TURFING WORK

The Contractor shall maintain all areas during the planting period and until final acceptance. The Contractor shall maintain all areas following final acceptance in accordance with Section 02935 EXTERIOR PLANT MATERIAL MAINTENANCE. Maintenance shall consist of watering, replanting, mowing, maintaining existing grades, and repair of erosion damage.

#### 3.12.1 Stand

A stand shall be defined as the planted area achieving a uniform live grass coverage having a density where the total bare spots do not exceed 2 percent of the total turfed area, bare spots are not larger than 150 mm square, and the grass is of a height sufficient to be capable of being mowed as specified in the mowing requirements contained in this contract.

3.12.2 Watering

Maintenance watering shall consist of daily watering. Water shall be applied each day over the entire planted area until the soil is thoroughly wet to a depth of four inches as determined by the Contracting Officer. During and following effective rainfall, watering shall be discontinued but shall be promptly resumed when directed by the Contracting Officer. Water shall be applied using portable aluminum lines with rotating sprinklers on the larger areas beyond the building and facilities. Spacing of the sprinklers shall not exceed 12 meters along the aluminum lines. Hoses with rotating sprinklers may be used for watering the smaller areas adjacent to the building.

3.12.3 Replanting

Bermudagrass seed should germinate within at least 14 days from planting. If, after that 14-day period a successful germination of a potential stand of grass is not present, the area shall be reseeded prior to the end of the planting season, or within the next 7 days after the 14-day germination period if after the planting season specified in PART 3 paragraph PLANTING SEASON.

3.12.4 Maintenance of Grades and Repair of Erosion Damage

It shall be the responsibility of the Contractor to maintain the original grades of the planted areas after commencement of planting operations and during the specified maintenance period. Damage to the finished surface from Contractor's operations shall be promptly repaired. In the event erosion occurs from either watering operations or from rainfall, such damage shall be repaired within 10 days from the date of the noted damage. Ruts, ridges, tracks, and other surface irregularities shall be corrected and replanted where required prior to acceptance.

3.12.5 Mowing

Vegetation shall be kept under control by mowing. Any time that the weed or grass growth reaches a height of 100 mm , the areas shall be mowed. Mowing shall be done with approved mowing machines in such manner that will leave a vegetation height of between 50 mm to 64 mm

-- End of Section --

# SECTION 02931

# PLANTING OF TREES, SHRUBS, AND VINES

**10/2000**

**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z60.1 | (1990) Nursery Stock |

AMERICAN JOINT COMMITTEE ON HORTICULTURAL NOMENCLATURE (AJCHN)

| | |
|---|---|
| AJCHN-01 | (1942, 2nd Ed.) Standard Plant Names |

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS (AOAC)

| | |
|---|---|
| AOAC-01 | Official Methods of Analysis |

COMMERCIAL ITEM DESCRIPTIONS (CID)

| | |
|---|---|
| CID A-A-1909 | (Basic; Notice 1; Canc. Notice 2) Fertilizer |

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Organic Soil Ammendment; G, {AM#0001} ED.

Certified copies of the analysis of each type of organic amendment material used in the project, made by an approved, independent, recognized laboratory in accordance with the current method of the AOAC-01. Testing shall be at the Contractor's expense. Testing shall be submitted for approval of the Contracting Officer before delivery of the peat.

SD-07 Certificates

The certificates listed below shall be submitted for approval prior to commencement of work:

Fertilizer; G,{AM#0001} ED.

One certificate for each type to be used in the project.

Soil Amendments; G,{AM#0001} ED.

Certificates for each type of soil amendment.

Peat Mulch; G,{AM#0001} ED.

Certificates for each type of peat mulch shall be submitted to the Contracting Officer showing type, percent of organic matter, origin, and the amount to be utilized on the project.

Woodbark Mulch; G,{AM#0001} ED.

Certificates shall list all information on the container label and the amounts of each type to be used on the project.

SD-11 Closeout Submittals

Plant Material; G,RE.

All necessary inspection certificates shall accompany the invoice for each shipment or order of stock, as may be required by law for the necessary transportation, and such certificates shall be filed with the Contracting Officer prior to acceptance of the materials.

## 1.3 INSPECTION

### 1.3.1 Plant Materials

All shipments or orders of plant material shall be properly inspected at the nursery or at the site by the Authorized Federal and State authorities.

## 1.4 DIGGING UP, WRAPPING, HANDLING AND DELIVERY

Plants shall be dug and prepared for shipment in a manner that will not cause any damage to the branches, shape, root system, and future development of the plants after replanting. Plants shall not be handled by the trunk or stems. Damaged plants will be rejected and shall be removed from the site.

### 1.4.1 Balled and Burlapped Plants

Balled and burlapped plants, designated BB in the list of required plants, shall be adequately balled with firm natural balls of soil in sizes as shown on the drawings. Balls shall be firmly wrapped with burlap or substitute approved cloth. No balled plant shall be planted if the ball is cracked, mushy, or broken, or if the stem is loose in the ball, either before or during the process of planting. Balled plants shall be lifted and handled from the bottom of the ball.

### 1.4.2 Container-Grown Plants

Container-grown plants, designated "C" in the list of required plants, shall have been grown in cans. Plants shall have sufficient roots to hold earth together intact after removal from containers without being rootbound.

### 1.4.4 Options as to Methods

If all other requirements are met, any plant other than trees (unless otherwise indicated on the drawings) may be furnished container-grown instead of balled and burlapped. Any substitutions shall be made only with approval of the Contracting Officer at no change in the contract price.

### 1.4.3 Shipment and Delivery

The Contractor shall promptly notify the Contracting Officer, in advance, when the plant material will be delivered and the manner of shipment. The Contractor shall furnish an itemized list, in duplicate, of the actual quantity of plant material in each delivery, in order to insure satisfactory coordination of delivery and to expedite the required inspection at the point of delivery. The itemized list of the plant material for each delivery shall include the pertinent data as specified in the list of required plants. This list and the necessary inspection certificates to accompany each plant or shipment shall be delivered to the Contracting Officer, prior to acceptance and planting of the plant material.

#### 1.4.3.1 Protection During Delivery

Plants shall be protected during delivery to prevent damage to the root balls or desiccation of leaves. Trees shall be protected during transportation by tying in the branches and covering all exposed branches. When shipment is made by truck, all plant material shall be packed to provide adequate protection against climatic, seasonal, and breakage injuries during transit. The tops shall be securely covered with tarpaulin or canvas to minimize wind-whipping and drying. When shipment is made by rail, box cars shall be carefully packed and adequately ventilated to prevent sweating of the plants during transit. Shipments made by rail to local or nearby freight yards shall be given special attention to insure prompt delivery and careful handling therefrom to the point of final delivery at the planting jobsite. Under no circumstances shall balled plants be dropped from box cars or trucks to the ground. A suitable method of handling shall be employed to preclude cracked or mushroomed plant balls at the point of delivery.

#### 1.4.3.2 Inspection Upon Arrival

Plant material shall be inspected upon arrival at the jobsite. Unacceptable plant material shall be removed from the jobsite.

#### 1.4.3.3 Commercial Fertilizer

Commercial fertilizer shall be delivered to the site in unopened original containers, each fully labeled, conforming to the applicable State fertilizer laws and bearing the trade name or trademark and warranty of the producer. Each sack shall bear the manufacturer's statement of analysis, indicating the percentages of available nitrogen, available phosphoric acid, and potash.

1.4.3.4 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis and name. In lieu of containers, soil amendments may be furnished in bulk and a certificate from the manufacturer indicating the above information shall accompany each delivery.

1.4.3.5 Mulch

Peat shall be delivered to the jobsite in unopened bags or in unbroken bales. Woodbark shall be delivered to the site in unopened containers and shall be fully labeled.

1.4.4 Protection Against Freezing and Drying Out

1.4.4.1 Plant Storage

Care shall be taken to avoid drying or damaging plants being moved from the nursery or storage area to the planting site. All plants shall be handled so that roots are adequately protected at all times from drying out and from other injury. Balled and burlapped plants shall be handled carefully to avoid cracking or breaking the earth ball. The balls of balled plants that cannot be planted immediately on delivery shall be well protected with soil or other acceptable material. The Contractor shall safeguard the unplanted plants during freezing weather by inside storage and other precautionary measures. Bare root plants shall be heeled out with roots completely covered with wet soil or other approved material immediately upon delivery.

1.4.4.2 Storage of Other Materials

Soil amendments shall be kept in dry storage away from contaminants. Storage of materials shall be in areas designated or as approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 PLANTS REQUIRED

The species (scientific and common names), size, and manner in which to be furnished, are given in the plant list shown on the drawings.

2.1.1 Substitutions

Plants of kinds other than those named in plant list will not be accepted unless specifically approved in writing by the Contracting Officer.

Proposed substitutes, in each case, must possess the same essential characteristics as the kind of plant actually specified in regard to appearance, ultimate height, shape, habit of growth, general soil and other requirements. In no case shall the average cost and value of substituted plants be less than the cost and value of plants actually specified. Plants of greater value may be accepted without additional cost to the Government.

## 2.2 PLANT MATERIALS

All plant material furnished shall be nursery-grown, well branched, full-foliaged, and well proportioned, particularly with respect to the width-height relationship, and shall have a fibrous root system. The Government may inspect plants at place of growth, but such inspection shall not preclude the right of rejection at the site.

### 2.2.1 Nomenclature

The scientific and common names of plants herein specified or shown on the drawings conform with the approved names given in AJCHN-01, Standard Plant Names, except that where local usage does not follow this standard, the accepted local names are given in parentheses.

### 2.2.2 Plant Material Labels

For the purpose of inspection and plant identification, durable, legible labels stating in weather-resistant ink the correct plant name and size, as specified in the list of required plants, shall be securely attached to all plants, bundles, and containers of plant material delivered at the planting site.

### 2.2.3 Quality and Size

Quality and size of plants shall be in accordance with rules and grading adopted by the American Association of Nurserymen, Inc., and included in ANSI Z60.1. All plants shall be of excellent quality and have a normal habit of growth and shall be sound, healthy, vigorous, and free from disease and insect infestations, and damage. Trees shall have single straight trunks unless otherwise specified. Any tree with weak thin trunk not capable of supporting itself when planted in the open will not be accepted. The minimum acceptable sizes of all plants, measured before pruning, with branches in normal position, shall conform to the measurements specified hereinafter in the list of required plants. Plants larger in size than specified may be used with the approval of the Contracting Officer, but the use of larger plants will make no change in contract price. If the use of larger plants is approved, the ball of earth or spread of roots shall be increased proportionately.

## 2.3 BURLAP

Burlap shall be made of jute and shall weigh not less than 255 ml per square meter (7.2 ounces per square yard) . Substitute cloth shall possess an equal strength and resistance to tearing.

## 2.4 COMMERCIAL FERTILIZER

Fertilizer shall be commercial grade, free flowing, uniform in composition and conforming to CID A-A-1909.

### 2.4.1 Dry Fertilizer

a. Granular fertilizer

As recommended by the soil test. Specified in Section 02925 ESTABLISHMENT OF TURF.

b. Controlled-Release Fertilizer

Consists of nitrogen-phosphorous-potassium ratio: 20 percent nitrogen 10 percent phosphorous, and 5 percent potassium. Controlled-release fertilizer may be in packet or tablet form.

## 2.5 SOIL AMENDMENTS

### 2.5.1 Sulphur

Sulphur shall be finely ground, raw, agricultural grade, with a purity of at least 98 percent.

### 2.5.2 Iron Sulphate

Iron sulphate shall be the fine salt form of the chemical $FeSO_4$, free of lumps, suitable for uniform mixing with soil.

### 2.5.3 Organic Material

Decomposed organic material such as well-aged cow manure, sphagnum peat, compost, or humus, elastic and homogeneous; free of decomposed colloidal residue, wood or trash; ph between 5.9 and 7.0; minimum 60 percent organic matter by weight; salt content less than 2 mmho/cm; maximum 15 percent moisture content.

## 2.6 MATERIAL FOR STAKING

### 2.6.1 Stakes and Braces

Stakes for supporting trees shall be square, straight, sound, rough sawn, free from knots, and not less than nominal 50 mm by 50 mm square. Cross braces on stakes shall be nominal 25 mm by 100 mm boards. Stakes and braces shall be painted green using approved wood stain or paint.

### 2.6.2 Wire

Wires for tying trees to stakes shall be annealed galvanized steel or steel of gages hereinafter specified.

### 2.6.3 Tree Supports

Tree supports shall be 50 x 300 mm straps of woven nylon or polypropylene with brass grommets for tie wires.

## 2.7 MULCH

Mulch shall consist of materials as specified below:

a. Peat

Peat shall be natural product of sphagnum moss or sedge peat, taken from a fresh-water site. Peat shall be free of lumps, roots, and stones or other foreign matter, and of such physical condition that the peat can be passed through a 13 mm (1/2-inch) mesh screen and can be readily incorporated with the topsoil. Peat shall have been conditioned in storage piles after excavation for at least 6 months, including one freezing and thawing period or processed with a dehydrator. Peat shall contain not less than 70 percent organic matter by weight on an ovendry basis.

b. Woodbark

At the Contractor's option, woodbark may be used as mulch. Woodbark shall be a natural product of pine bark. The bark shall be manufactured for the use of plant mulch and shall be free from weed, seed, soil, plant diseases and insects.

## 2.8 TOPSOIL

Topsoil shall be obtained from the top 150 mm of ground surface of the site. Select topsoil that is fertile, friable, natural surface soil, free of subsoil, clods, shale, trash, toxic substances, stones 50 mm in maximum dimension or larger, Bermudagrass, Johnsongrass, nutgrass (Cyperus rotundus), or other objectionable and hard to eradicate weeds or grasses.

## 2.9 Amended Topsoil

Amend topsoil as recommended by the soil report specified in Section 02925 ESTABLISHMENT OF TURF as a basis for bid, amend as follows: one-part organic material per 4-parts topsoil; 25 gm. Diamonium phosphate and 3 gm iron sulfate per square meter.

## 2.10 WATER

Water shall be kept free from oil, acids, alkali, salt, and other substances harmful to the growth of plants. The source of water and service outlets used shall be subject to approval of the Contracting Officer.

# PART 3 EXECUTION

## 3.1 PLANTING SEASON

The planting season for trees, shrubs, and vines shall be from l January to 15 March. Planting of trees, shrubs, and vines for all phases of this contract shall be accomplished within that period. Actual planting shall be performed during the specified periods only when weather and soil conditions are suitable and in accordance with locally accepted practice, as approved by the Contracting Officer. Deviation from the planting dates will be permitted only when approved in writing by the Contracting Officer.

## 3.2 OBSTRUCTIONS BELOW GROUND

Any rock or other underground obstruction shall be removed to the depth necessary to permit proper planting, according to plans and specifications. If underground construction, obstructions, or rock are encountered in excavation of planting areas, other locations for the planting may be selected by the Contracting Officer. Explosives may be used for removal of rock or oil foundation structures only where and as expressly approved by the Contracting Officer. The Contractor shall familiarize himself with all existing underground utility locations and shall avoid damaging them during planting operations. The Contractor shall repair at his own expense any damage to existing utilities and such repairs shall be in a manner directed by the Contracting Officer.

## 3.3 PLANTING OPERATIONS

### 3.3.1 Layout of Major Planting

Locations for plants and outlines of areas to be planted shall be marked on the ground by the Contractor and approved by the Contracting Officer before any excavation is made. No shrubs shall be planted less than from a building unless specifically indicated on the drawings or designated by the Contracting Officer. In the event obstructions are encountered which prevent planting as indicated, the plant or plants will be planted in a new location, as directed by the Contracting Officer.

### 3.3.2 Protection of Planting Areas

Before excavations are made, precautionary measures shall be taken to protect all turfed areas that are to be trucked over and upon which soil is to be temporarily stacked pending removal or reuse of the soil for the filling of holes, pits, and beds. Existing trees, shrubbery, and beds that are to be preserved shall be barricaded in a manner to afford effective protection during planting operations.

### 3.3.3 Excavation for Planting

Excavation for planting shall include the stripping and stacking of all acceptable topsoil encountered within the areas to be excavated for trenches, plant pits, and planting beds. Most of the excavated material will not be acceptable for backfill. Except as otherwise indicated, excavations of trenches, tree holes and plant pits shall extend to the required subgrades as indicated on the drawings but in no case shall be less than as specified. Plant pits shall be circular in outline and shall have vertical sides and flat bottoms, or may be machine dug in a square shape with vertical sides and flat bottoms provided the minimum width of square pits is as great as the diameter for the circular pits. The minimum depths of plant pits shown on the drawings shall be measured from finished grade. Planting beds in which ground cover or similar planting are indicated shall be excavated to the depth shown on the drawings and as required to eliminate Bermudagrass, Johnsongrass, nutgrass (Cyperus rotundus) or similar objectionable vegetation which would seriously compete with the plantings. In the event such vegetation is present, the surface soil shall be stripped to a depth of 150 mm to 305 mm, as required to eliminate underground rootstalks or rhizomes.

3.3.4 Preparation of Planting Beds (PB)

3.3.4.1 Preparation (For Use Without Planters)

The planting beds for ground cover, outlines of which are shown on the drawings, shall be excavated to a depth of 380 mm. Unacceptable excavated soil shall be disposed of as directed by the Contracting Officer. During excavation operations all roots, stones, grade stakes or other objects 50 mm in maximum dimension or larger shall be removed from beds and disposed of as directed by the Contracting Officer. Plants to be planted in plant beds are indicated by PB in the legend on the drawings.

3.3.4.2 Backfilling

The plant beds shall be backfilled with ammended topsoil specified herein. Organic material and ammended shall then be spread uniformly over the bed to a depth of 150 mm, and shall be mixed and incorporated into the soil to a depth of 230 mm using a roto-tiller or similar type of equipment to obtain a uniform and well pulverized soil mix. During tillage operations, all roots, stones, stakes, or other objectionable objects shall be removed from the beds and disposed of as directed. Beds shall be brought to a smooth even surface conforming to established grades and the details shown on the drawings after full settlement has occurred. The mixed soil in the beds shall be moist at the time the plants are set.

3.3.5 Planting Pit Sizes

Minimum depth and diameter or width of planting pits for trees, shrubs, and vines shall be as shown in the plant list on the drawings. Plants to be placed outside of planting beds shall be planted in pits with depths and diameters as shown on drawings for each plant.

3.3.6 Disposal of Excess Soil

Acceptable excess excavated topsoil shall be wasted uniformly over nearby low or rough lawn areas, or otherwise disposed of as approved by the Contracting Officer. Excess soils not required or not suitable for above usage shall be disposed of on or off the reservation as directed by the Contracting Officer, within 24 hours following excavation.

3.3.7 Setting Plants

Except as otherwise specified, plants shall be planted in pits and shall be set at the level shown in the details on the drawings. Trees shall be set plumb and rigidly braced in position until the soil has been tamped solidly around the ball or roots. Plants shall be planted in ammended topsoil, as specified herein, which shall be thoroughly settled by watering and tamping. To compensate for shrinkage, the finished grade of ammended topsoil prior to watering shall be fixed at an elevation 10 percent of the fill depth higher than the desired finished grade, unless otherwise directed by the Contracting Officer. To facilitate watering, each plant shall be set approximately 50 mm below the grade of the existing ground surface to form a saucer as shown on the drawings.

#### 3.3.7.1 Balled Plants

Balled-and-burlapped (BB) plants shall be placed on a minimum of 150 mm of ammended, compacted topsoil, as shown on the drawings, that has been hand tamped prior to placing plants. Plants shall then be placed in the plant pit, and ammended topsoil shall be tamped to fill all voids under the base and around the ball to a height of one-half the depth of the ball. Cloth, ropes, wires, and other wrapping material shall be cut away from the top of the balls, and backfilling with ammended topsoil shall be completed. In no case shall cloth be pulled out from under balls.

#### 3.3.7.2 Container-Grown Plants

Containers shall be opened, and the plants carefully removed so that the earth around the roots of the plants remains unbroken. Plants shall then be planted in the same manner as balled plants.

### 3.3.8 Staking of Trees

#### 3.3.8.1 Balled and Burlapped Trees

Balled and burlapped trees shall be staked as they are planted as shown on the drawings, with a 25 mm by 100 mm board cross brace securely bolted between stakes unless otherwise approved.

### 3.3.9 Pruning

Pruning shall be limited to the minimum necessary to remove injured twigs and branches, and to compensate for the loss of roots during transplanting, but never to exceed one-half of the branching structure. With the approval of the Contracting Officer, pruning may be done before delivery of plants, but not before plants have been inspected and approved. All cuts shall be made flush leaving no stubs. Cuts over 19 mm in diameter shall be painted with an approved tree-wound paint. To further aid in the recovery of transplanted trees, the leaves may be stripped prior to shipment where this is a locally accepted practice and approved by the Contracting Officer. Evergreens shall not be pruned except to remove injured branches.

### 3.3.10 Mulching

After planting and application of fertilizer, plants shall be mulched over entire saucer area around each plant to a depth of 100 mm.

## 3.4 MAINTENANCE OPERATIONS

Maintenance operations shall begin immediately after each plant is planted and shall continue until all landscaping and turfing work under this contract is completed and accepted. Maintenance shall continue after acceptance in accordance with section 02935 EXTERIOR PLANT MATERIAL MAINTENANCE. Plants shall be kept in a healthy growing condition by watering, pruning, spraying, weeding, cultivating, and by any other necessary operations of maintenance. Plant saucers and planting beds shall be kept free of weeds, grass, and other undesired vegetative growth. Plants shall be inspected at least weekly by the Contractor during the maintenance period and necessary work shall be promptly performed. Watering will be required when, in the opinion of the Contracting Officer, the soil moisture is below optimum level for best plant growth. Weekly watering will be required when, in the opinion of the Contracting Officer, the soil moisture is below optimum level for best plant growth. Weekly watering will normally be required during dry weather.

## 3.5 REPLACEMENT

During the planting period, plants that die or are, in the opinion of the Contracting Officer, in an unhealthy, unsightly, or impaired condition, shall be replaced by the Contractor prior to the commencement of the maintenance period. Three days prior to the conclusion of the maintenance period, the Contracting Officer and the Contractor will make an inspection of the work to determine condition of all plants. All plants that are dead or not in a healthy growing condition, as determined by the Contracting Officer, will be noted. All plants noted to be unhealthy, unsightly, or damaged, shall be removed from the site and replaced with healthy plants of the same kinds and sizes as originally specified during the period from installation to one-year after acceptence . Such replacements shall be made in the same manner as specified for the original planting, except all trees shall be balled-and-burlapped, and at no extra cost to the Government. Maintenance of the replacements will be by the Government after the original maintenance period.

-- End of Section --

# SECTION 03100

## STRUCTURAL CONCRETE FORMWORK
**05/98**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 347R | (1994) Guide to Formwork for Concrete |

AMERICAN HARDBOARD ASSOCIATION (AHA)

| | |
|---|---|
| AHA A135.4 | (1995) Basic Hardboard |

U.S. DEPARTMENT OF COMMERCE (DOC)

| | |
|---|---|
| PS-1 | (1996) Voluntary Product Standard - Construction and Industrial Plywood |

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Formwork; G, RE.

Drawings showing details of formwork, including dimensions of fiber voids, joints, supports, studding and shoring, and sequence of form and shoring removal.

SD-03 Product Data

Design.

Design analysis and calculations for form design and methodology used in the design.

Form Materials.

Manufacturer's data including literature describing form materials, accessories, and form releasing agents.

Form Releasing Agents.

Manufacturer's recommendation on method and rate of application of form releasing agents.

SD-04 Samples

Fiber Voids.

One sample unit of fiber voids prior to installation of the voids.

SD-07 Certificates

Fiber Voids.

Certificates attesting that fiber voids conform to the specified requirements.

## 1.3 DESIGN

Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

## 1.4 STORAGE AND HANDLING

Fiber voids shall be stored above ground level in a dry location. Fiber voids shall be kept dry until installed and overlaid with concrete.

# PART 2 PRODUCTS

## 2.1 FORM MATERIALS

### 2.1.1 Forms For Class A and Class B Finish

Forms for Class A and Class B finished surfaces shall be plywood panels conforming to PS-1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

### 2.1.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to PS-1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

#### 2.1.3 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 6 mm nor more than 25 mm deep and not more than 25 mm in diameter. Removable tie rods shall be not more than 38 mm in diameter.

#### 2.1.4 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

#### 2.1.5 Fiber Voids

Fiber voids shall be the product of a reputable manufacturer regularly engaged in the commercial production of fiber voids. The voids shall be constructed of double faced, corrugated fiberboard. The corrugated fiberboard shall be fabricated of standard kraft paper liners, impregnated with paraffin, and laminated with moisture resistant adhesive, and shall have a board strength of 20 kg per square centimeter. Voids which are impregnated with paraffin after construction, in lieu of being constructed with paraffin impregnated fiberboard, are acceptable. Voids shall be designed to support not less than 4900 kg per square meter. To prevent separation during concrete placement fiber voids shall be assembled with steel or plastic banding at 1.22 meters on center maximum, or by adequate stapling or gluing as recommended by the manufacturer. Fiber voids placed under concrete slabs and that are 200 mm in depth may be heavy duty "waffle box" type, constructed of paraffin impregnated corrugated fiberboard.

### 2.2 VOID RETAINERS

#### 2.2.1 Precast Concrete

Precast concrete units shall be constructed as shown on the Drawings.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Formwork

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in

Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, the forms shall fit over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

3.1.2 Fiber Voids

Voids shall be placed on a smooth firm dry bed of suitable material, to avoid being displaced vertically, and shall be set tight, with no buckled cartons, in order that horizontal displacement cannot take place. Each section of void shall have its ends sealed by dipping in paraffin, with any additional cutting of voids at the jobsite to be field dipped in the same type of sealer, unless liners and flutes are completely impregnated with paraffin. Prior to placing reinforcement, the entire formed area for slabs shall be covered with a minimum 4 mil thick polyethylene sheet. The greatest widths and lengths practical shall be used to eliminate joints wherever possible. Joints shall be lapped and taped. Place 1.22 x 2.44 m minimum flat sheets of {AM#0001} 6 mm protective cover board over the poly sheeting. Joints between fiber voids shall be sealed with a moisture resistant tape having a minimum width of 75 mm (3 inch). If voids are destroyed or damaged and are not capable of supporting the design load, they shall be replaced prior to placing of concrete.

3.1.3 Void Retainers

Void retainers shall be installed, continuously, on both sides of fiber voids placed under grade beams in order to retain the cavity after the fiber voids biodegrade.

3.2 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.4 REMOVAL OF FORMS

Forms shall be removed preventing injury to the concrete and ensuring the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. Supporting forms or shores shall not be removed before the concrete strength has reached 70 percent of design strength, as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

TABLE 1

TOLERANCES FOR FORMED SURFACES

| | |
|---|---|
| 1. Variations from the plumb: | In any 3 m of length -------- 6 mm |
| a. In the lines and surfaces of columns, piers, walls and in arises | Maximum for entire length -- 25 mm |
| b. For exposed corner columns, control-joint grooves, and other conspicuous lines | In any 6 m of length -------- 6 mm<br>Maximum for entire length 13 mm |
| 2. Variation from the level or from the grades indicated on the drawings: | In any 3 m of length ------- 6 mm<br>In any bay or in any 6 m of length ------------------- 10 mm |
| a. In slab soffits, ceilings beam soffits, and in arises,measured before removal of supporting shores | Maximum for entire length - 20 mm |
| b. In exposed lintels, sills,parapets, horizontal grooves, and other conspicuous lines | In any bay or in any 6 m of length -------------------- 6 mm<br>Maximum for entire length - 13 mm |

TABLE 1

TOLERANCES FOR FORMED SURFACES

| | |
|---|---|
| 3. Variation of the linear building lines from established position in plan | In any 6 m ---------------- 13 mm<br>Maximum ------------------- 25 mm |
| 4. Variation of distance between walls, columns, partitions | 6 mm per 3 m of distance, but not more than 13 mm in any one bay, and not more than 25 mm total variation |
| 5. Variation in the sizes and locations of sleeves, floor openings, and wall opening | Minus --------------------- 6 mm<br>Plus --------------------- 13 mm |
| 6. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls | Minus -------------------- 6 mm<br>Plus -------------------- 13 mm |
| 7. Footings: | |
| a. Variation of dimensions in plan | Minus ------------------- 13 mm<br>Plus -------------------- 50 mm<br>when formed or plus 75 mm when placed against unformed excavation |
| b. Misplacement of eccentricity | 2 percent of the footing width in the direction of misplacement but not more than --------- 50 mm |
| c. Reduction in thickness | Minus ----------------- 5 percent of specified thickness |
| 8. Variation in steps: | Riser ---------------------- 3 mm |
| a. In a flight of stairs | Tread ---------------------- 6 mm |
| b. In consecutive steps | Riser ---------------------- 2 mm<br>Tread ---------------------- 3 mm |

-- End of Section --

# SECTION 04220

# NONBEARING MASONRY VENEER/STEEL STUD WALLS
**01/02**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC ASD Manual | (1989) Manual of Steel Construction Allowable Stress Design |

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI Cold-Formed Mnl | (1996) Cold-Formed Steel Design Manual |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 123/A 123M | (2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 153/A 153M | (2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 36/A 36M | (2000a) Carbon Structural Steel |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 82 | (1997a) Steel Wire, Plain, for Concrete Reinforcement |
| ASTM C 1002 | (2000) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases |
| ASTM C 1177/C 1177M | (1999) Glass Mat Gypsum Substrate for Use as Sheathing |
| ASTM C 216 | (2000) Facing Brick (Solid Masonry Units Made from Clay or Shale) |
| ASTM C 270 | (2000) Mortar for Unit Masonry |

| | |
|---|---|
| ASTM C 578 | (1995) Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM C 591 | (1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C 665 | (1998) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing |
| ASTM C 67 | (2000) Sampling and Testing Brick and Structural Clay Tile |
| ASTM C 780 | (2000) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry |
| ASTM C 79/C 79M | (2000) Treated Core and Nontreated Core Gypsum Sheathing Board |
| ASTM C 954 | (2000) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness |
| ASTM C 955 | (2000a) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases |
| ASTM D 1056 | (2000) Flexible Cellular Materials - Sponge or Expanded Rubber |
| ASTM D 1330 | (1985; R 1995el) Rubber Sheet Gaskets |
| ASTM D 1667 | (1997) Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam) |
| ASTM D 2103 | (1997) Polyethylene Film and Sheeting |
| ASTM D 226 | (1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE Hdbk-IP | (1997) Handbook, Fundamentals I-P Edition |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.3 | (1998) Structural Welding Code - Sheet Steel |

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, ED

Details of cold-formed steel framing and support around openings, including framing connections, steel lintels, steel shelf angles, attachment to other building elements and bridging. Drawings shall indicate thickness, material, dimensions, protective coatings, and section properties of all steel lintels and shelf angles used in exterior wall framing. Drawings shall also indicate size and type of all fasteners including size and type of all welds. If the Contractor opts to furnish inch-pound (IP) CMU products, drawings showing elevation of walls exposed to view and indicating the location of all cut CMU products shall be submitted for approval.

SD-04 Samples

Expansion Joint Materials.
Clay or Shale Brick; G, ED.
Sample Panel; G, ED.

A portable panel, approximately 600 by 600 mm , containing approximately 24 brick facings to establish the range of color and texture. One of each type of masonry veneer anchor used.

SD-06 Test Reports

Masonry Veneer/Steel Stud Wall System; G, ED.

Calculations demonstrating the structural adequacy of steel lintels and shelf angles for the calculated gravity loads being supported; this analysis shall be in accordance with AISC ASD Manual. Test results demonstrating that the veneer anchors are structurally adequate to resist the specified loadings shall be submitted for approval. Calculations demonstrating the insulation shown on the drawings provides the specified U-value for heat transmission of the completed exterior wall construction; this analysis shall be in accordance with ASHRAE Hdbk-IP. Manufacturer's descriptive data and installation instructions for the insulation, the vapor barrier and the moisture barrier.

SD-07 Certificates

Clay or Shale Brick.

Joint Reinforcement.
Expansion Joint Materials.
Insulation.
Exterior Sheathing.
Moisture Barrier.
Vapor Retarder.
Veneer Anchors.
Welding.

Certificates stating that the materials and welders meet the requirements specified. Each certificate shall be signed by an authorized certification official and shall include their organization and position and shall identify the products covered under their certifying signature.

## 1.3 SAMPLE PANEL

After the material samples are approved and prior to starting masonry work, a sample masonry panel shall be built on the project site where directed. The sample panel shall be not less than 1.8 m long by 1.2 m high. The panel shall be of typical wall thickness for the construction represented. The panel shall show color range, texture, bond pattern, expansion joints, and cleaning of the masonry as required in the work. The panel shall also show cold-formed steel framing, insulation, gypsum wallboard, gypsum sheathing, moisture barrier, vapor barrier, veneer anchors, joint reinforcement, steel shelf angles, flashing and weep holes. The approved sample panel shall be used as a standard of workmanship required in the actual installation. The sample panel shall be protected from weather and construction operations and shall not be removed until the masonry veneer/steel stud wall work has been completed and accepted.

## 1.4 DELIVERY, HANDLING AND STORAGE

Materials shall be delivered and handled avoiding chipping, breakage, bending or other damage, and contact with soil or other contaminating materials. The masonry products shall be stored off the ground and protected from inclement weather. Cementitious materials shall be delivered in unopened containers plainly marked and labeled with manufacturer's names and brands. Cementitious materials shall be stored in dry, weather-tight enclosures or covers. Sand and other aggregates shall be stored preventing contamination or segregation and under a weather-tight covering permitting good air circulation. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content galvanizing repair paint whenever necessary to prevent the formation of rust. Insulation, moisture barrier, and gypsum sheathing shall be stored in dry, well ventilated, weather-tight areas protected from sunlight and excessive heat. Air infiltration type vapor barrier shall be stored in accordance with the manufacturer's recommendations.

## 1.5 EFFLORESCENCE TESTS

Efflorescence tests shall be performed by an approved commercial testing laboratory. Sampling for the tests shall be the responsibility of the Contractor. Brick shall be sampled and tested for efflorescence in accordance with ASTM C 67 and the rating shall be: "not effloresced".

## PART 2 PRODUCTS

### 2.1 VENEER WYTHE

The source of masonry materials which will affect the appearance of the finished work shall not be changed after the work has started except with the Contracting Officer's approval. The Contractor has the option to use either hard metric or substitute inch-pound (soft-metric) masonry products. If the Contractor decides to substitute inch-pound masonry products, the following additional requirements shall be met:

a. The dimensions indicated on the drawings shall not be altered to accommodate inch-pound masonry products either horizontally or vertically. The 100 mm building module shall be maintained, except for the actual physical size of the masonry products themselves.

b. Mortar joint widths shall be maintained as specified.

c. Indicated reinforcing bar spacing shall not be exceeded. Inch-pound masonry products shall accommodate reinforcing bar placement. Reinforcing bars shall not be cut, bent or eliminated to fit into the inch-pound masonry product modules.

d. Masonry inch-pound products shall not be reduced in size by more than one-third (1/3) in height and one-half (1/2) in length. Masonry products shall not be cut at ends of walls, corners, and other openings.

e. Cut, exposed masonry products shall be held to a minimum and shall be located where they will have the least impact on the aesthetics of the facility.

f. Other building components built into the masonry products, such as window frames, door frames, louvers, fire dampers, etc., that are required to be metric, shall remain metric.

g. Additional metric guidance shall conform to Section 01415 METRIC MEASUREMENTS.

#### 2.1.1 Clay or Shale Brick

Clay or shale brick veneer shall be masonry units conforming to ASTM C 216, Type FBS. Color range and texture shall be as indicated on the drawings and shall conform to the approved sample. Brick color is locally known as "Dyess Blend" or "Cherokee Mingle". Grade SW shall be used for all brickwork. Brick unit sizes shall be modular.

### 2.2 MORTAR

Mortar shall conform to ASTM C 270, Type S. Mortar mix shall be based on proportion specifications. Laboratory testing of mortar shall be in accordance with the preconstruction evaluation of mortar section of ASTM C 780. Mortar shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.2.1 Masonry Cement

Masonry cement shall not be used.

2.2.2 Admixtures

Cold weather, accelerating admixtures are prohibited.

2.3 JOINT REINFORCEMENT

Joint reinforcement shall be of steel wire conforming to ASTM A 82. Fabrication shall be by welding. Tack welding will not be permitted. Reinforcement shall be zinc-coated after fabrication in accordance with ASTM A 153/A 153M, Class B-2. Joint reinforcement shall consist of at least 1 continuous longitudinal wire in the veneer wythe. Minimum wire cross section shall be 11 square mm (0.017 square inches).

2.4 COLD-FORMED STEEL FRAMING

Cold-formed framing shall consist of steel studs, top and bottom tracks, runners, horizontal bridging, and other cold-formed members and other accessories. All members and components made of sheet steel shall be hot-dip galvanized in accordance with ASTM A 653/A 653M with a minimum coating thickness of G 60. Framing covered herein shall be used only in framing the exterior masonry veneer steel stud wall system as indicated on the detail drawings. Metal framing for interior partitions are specified in Section 09250 GYPSUM BOARD.

2.4.1 Steel Studs

Studs shall be furnished as shown in the contract drawings. {AM#0001} <u>Minimum thickness for all exterior studs shall be 18 gage.</u>

2.4.2 Runners, Tracks, Bridging and Accessories

Cold-formed steel sheet framing members, components, and accessories, other than the steel studs, shall conform to ASTM C 955 and be of steel conforming to ASTM A 653/A 653M, Grade 33, having a minimum yield strength of 230 MPa.

2.5 INSULATION

The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

2.5.1 Blanket Insulation

Insulation placed between the steel studs shall be batt or blanket type mineral wool conforming to ASTM C 665, Type I.

### 2.5.2 Rigid Board-Type Insulation

Insulation for wall cavities shall be rigid board-type insulation. Rigid board-type insulation shall be either polystyrene conforming to ASTM C 578, Type I or II, Grade 2 or polyurethane conforming to ASTM C 591. Insulation thickness R-values are shown on the Contract Drawings.

## 2.6 GYPSUM WALLBOARD

Gypsum wallboard that is installed on the interior side of the cold-formed steel framing system shall be as specified in Section 09250 GYPSUM BOARD.

## 2.7 EXTERIOR SHEATHING

Glass mat gypsum sheathing shall conform to ASTM C 79/C 79M and ASTM C 1177/C 1177M. Glass mat gypsum sheathing shall have a water-resistant core with a water-resistant glass mat embedded onto core and shall have a zero flame, zero smoke developed, and shall have mold and mildew resistant surface.

## 2.8 MOISTURE PROTECTION

### 2.8.1 Moisture Barrier

The moisture barrier shall be 6.7 kg asphalt-saturated felt conforming to ASTM D 226 Type I (No. 15).

### 2.8.2 Vapor Retarder

The vapor retarder shall be polyethylene film conforming to ASTM D 2103, 0.15 mm (6 mil) minimum thickness.

### 2.8.3 Staples

Staples for attaching the moisture barrier to the exterior sheathing shall be the type and size best suited to provide a secure connection. Staples shall be made from either galvanized steel or stainless steel wire.

### 2.8.4 Joint Tape

Tape for sealing the joints in the vapor retarder shall be laminated tape with pressure sensitive adhesive as recommended by the manufacturer of the polyethylene film.

## 2.9 VENEER ANCHORS

Anchor assemblies for the attachment of the masonry veneer to the cold-formed steel framing, structural steel and/or concrete beam and column members, and concrete floor slabs shall be as shown. Length of anchor wires shall be such that the outermost wires lie between 32 mm from each face of the masonry veneer. Anchors wires shall not have drips. Wires for veneer anchors shall be rectangular or triangular hoops formed from 5 mm diameter steel wire conforming to ASTM A 82. Anchor assemblies including wires and anchor plates shall be hot-dip galvanized conforming to ASTM A 153/A 153M, Class B-2. The veneer anchor shall have a minimum capacity of 900 newtons. The load-displacement capacity of each veneer anchor, both in direct pull-out for tension and compression, shall be not less than 350 kilo newtons per meter (2000 pounds per inch) (or a deflection of 2.85 mm per kilo newton (0.05 inches per 100 pounds) of load in tension or compression). In the direction perpendicular to the masonry veneer, the anchor assembly shall have a maximum play of 1.6 mm.

2.9.1 Adjustable Pintle-Eye Type Wire Anchors

Adjustable pintle-eye type wall anchors shall be two pieces rectangular type double pintle anchors.

2.10 CONNECTIONS

Screws, bolts and anchors shall be hot-dip galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate.

2.10.1 Framing Screws, Bolts and Anchors

Screws, bolts and anchors used in the assembly of the cold-formed steel framing system shall be as shown. Screw, bolt and anchor sizes shall be shown on the detail drawings.

2.10.2 Welding

Welded connections shall be designed and all welding shall be performed in accordance with AWS D1.3, as modified by AISI Cold-Formed Mnl. Welders shall be qualified in accordance with AWS D1.3. All welds shall be cleaned and touched-up with zinc-rich paint.

2.10.3 Veneer Anchor Screws

Screws for attachment of the veneer anchors to the cold-formed steel framing members shall be as required by design to provide the needed pullout load capacity but not less than No. 12. Screws shall be shown on the detail drawings. The length of screws shall be such that the screws penetrate the holding member by not less than 16 mm.

2.10.4 Gypsum Sheathing Screws

Screws for attachment of gypsum sheathing to cold-formed steel framing shall conform to ASTM C 1002, Type S or ASTM C 954.

2.11 SYNTHETIC RUBBER WASHERS

Synthetic rubber washers for placement between veneer anchors and the moisture barrier on the outside face of the exterior sheathing shall conform to ASTM D 1330, Grade I.

2.12 EXPANSION JOINT MATERIALS

Expansion joint materials shall be bellows or U-shaped type conforming to Section {AM#0001} 07601 SHEET METALWORK, GENERAL. Premolded type shall be closed-cell cellular rubber conforming to ASTM D 1056 or closed-cell vinyl or polyvinyl chloride conforming to ASTM D 1667.

## 2.13 FLASHING

Flashing shall conform to the requirements in Section {AM#0001} 07601 SHEET METALWORK, GENERAL. Flashing shall be supplied in a continuous sheet extending from the exterior sheathing across the cavity and through the masonry veneer as shown.

## 2.14 STEEL LINTELS AND SHELF ANGLES

Steel shapes used for lintels and shelf angles shall conform to ASTM A 36/A 36M. Lintels and shelf angles shall be provided as shown. These steel members shall be hot-dip galvanized in accordance with ASTM A 123/A 123M.

## 2.15 SEALANTS

Sealants shall be as specified in Section 07900 JOINT SEALING. Caulking is prohibited.

# PART 3 EXECUTION

## 3.1 GENERAL INSTALLATION REQUIREMENTS

Wall sections, types of construction and dimensions shall be as shown. Metal door and window frames and other special framing shall be built and anchored into the wall system as indicated.

## 3.2 STEEL STUD WALL FRAMING

The top track of the stud wall system shall be slip jointed to accommodate vertical deflections of the supporting members as shown on the drawings. Both flanges of all steel studs shall be securely fastened with screws to the flanges of the top and bottom tracks as shown on the drawings. All details for affixing steel studs to runners and all other sheet steel framing members along with all details necessary for anchorage of the steel stud wall system to the building structural systems shall be as shown on the drawings. Horizontal bridging shall be provided as necessary. Studs shall be spaced as indicated on the drawings. Coordinate stud spacing with sheathing and anchor requirements. At wall openings for doors, windows and other similar features, the framing system shall provide for the installation and anchorage of the required subframes or finish frames. Steel frames shall be securely attached through built-in anchors to the nearest stud on each side of the opening with self-drilling screws. Double studs shall be provided at both jambs of all door openings. Door frames and other built-in items shall be grouted solid.

## 3.3 STEEL SHELF ANGLES

Unless otherwise shown, steel shelf angles shall be provided in segments that do not exceed 3.0 m in length. At building corners, shelf angle segments shall be mitered and securely attached together by welding with legs no less than 1.2 m where possible. Shelf angle segments shall not be connected together but instead shall be installed with 6 mm wide gaps between the segments. Fabrication and erection tolerances shall be in accordance with the AISC Code of Standard Practice, as indicated in AISC ASD Manual.

3.4 INSULATION

The actual installed thickness of insulation shall provide a maximum thermal R as shown on the Contract Drawings for the completed exterior wall construction as determined in accordance with ASHRAE Hdbk-IP. Insulation thickness shall be as shown on the approved drawings. Installation, except as otherwise specified or shown, shall be in accordance with the manufacturer's instructions which shall be approved by the Contracting Officer. Insulation shall be installed between wall framing members. Rigid insulation shall be installed in accordance with the manufacturer's instructions with proper connections through the insulation to prevent the insulation from carrying loads directly. Insulation with facings shall be secured to the sides of the framing members to provide a continuous seal so that the entire weight of the insulation is carried by the framing members. Where electrical outlets, ducts, pipes, vents or other utility items occur, insulation shall be placed on the dry side of the item away from excessive humidity.

3.5 GYPSUM WALLBOARD

Gypsum wallboard shall be installed on the interior face of the cold-formed steel framing system. Installation shall be as specified in Section 09250 GYPSUM BOARD except at vertical slip joints, the gypsum wallboard shall be connected to the vertical studs to prevent movement at the slip joint.

3.6 EXTERIOR SHEATHING

Sheathing shall be installed on the exterior face of the cold-formed steel framing system with self-drilling screws. Screws shall be located a minimum of 10 mm from the ends and edges of sheathing panels and shall be spaced not more than 200 mm on each supporting member except at vertical slip joints, the sheathing shall be connected to the vertical studs to prevent movement of the slip joint. Edges and ends of gypsum sheathing panels shall be butted snugly with vertical joints staggered to provide full and even support for the moisture barrier. Holes and gaps resulting from abandoned screw installations, from damage to panels, and from cutting and fitting of panels at junctures with doors, windows, foundation walls, floor slabs and other similar locations shall be filled with exterior rubber-base caulk.

3.7 MOISTURE PROTECTION

3.7.1 Moisture Barrier

The asphalt-saturated felt or other approved moisture barrier shall be installed on the outer face of the exterior sheathing. The moisture barrier shall be installed horizontally and shingled with each sheet lapped not less than 150 mm over the sheet below. Vertical end joints shall be lapped not less than 150 mm and shall be staggered. Attachment of the moisture barrier shall be with staples spaced not greater than 400 mm on center or as required by the manufacturer.

### 3.7.2 Vapor Retarder

A vapor retarder shall be installed between the steel studs and the exterior sheathing. The vapor retarder shall be installed in accordance with the manufacturer's recommendations to form a complete retarder to vapor infiltration. The joints shall be lapped and sealed with tape.

## 3.8 VENEER ANCHORS

Veneer anchors shall be attached with screws through the sheathing and rigid insulation to the steel studs or other support members at the locations shown. When rigid insulation is used, the method of connecting the veneer anchor through the insulation shall be approved by the Contracting Officer. Veneer anchors shall be installed with the outermost wires lying between 16 mm from each face of the masonry veneer. Synthetic rubber washers shall be used between the anchor connector plates and the moisture barrier. A clutch torque slip screw gun shall be used on screws attaching veneer anchors to cold-formed steel members. Veneer anchors with corrugated sheet metal or wire mesh members extending across the wall cavity shall not be used. There shall be one veneer anchor for each 0.2 square meters of wall and shall be attached to steel studs and other supports with a maximum spacing of 600 mm on center. For pintle-eye anchors the vertical distance between the pintle section horizontal wires and the eye section horizontal wires shall not exceed 13 mm.

## 3.9 FLASHING

Continuous flashing shall be provided at the bottom of the wall cavity just above grade. Flashing shall also be provided above and below openings at lintels and sills, at shelf angles, and as indicated on the drawings. Flashing shall be as detailed and as specified in Section {AM#0001} 07601 SHEET METALWORK, GENERAL. Flashing shall be lapped a minimum of 150 mm at joints and shall be sealed with a mastic as recommended by the flashing manufacturer. Ends over doors, windows and openings shall be turned up and secured. Flashing shall be lapped under the moisture barrier a minimum of 150 mm and securely attached to the gypsum sheathing. Flashing shall extend through the exterior face of the masonry veneer and shall be turned down to form a drip.

## 3.10 MASONRY VENEER

Exterior masonry wythes shall be constructed to the thickness indicated on the drawings. A cavity consisting of an air space will be provided between the moisture barrier and the masonry veneer. Masonry veneer shall not be installed until the exterior sheathing, moisture barrier, veneer anchors and flashing have been installed on the cold-formed steel framing system. Extreme care shall be taken to avoid damage to the moisture barrier and flashing during construction of the masonry veneer. Any portion of the moisture barrier and flashing that is damaged shall be repaired or replaced prior to completion of the veneer. Masonry shall be placed in running bond patternand longitudinal reinforcement shall be as indicated on the drawings. Vertical joints on alternating courses shall be aligned and kept vertically plumb. Solid masonry units shall be laid in a non-furrowed full bed of mortar, beveled and sloped toward the center of the wythe on which the mortar is placed. Units shall be shoved into place so that the vertical mortar joints are completely full and tight. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned and relaid. Mortar which protrudes more than 13 mm into the cavity space shall be removed. Means shall be provided to ensure that the cavity space is kept clean of mortar droppings and other loose debris. Chases and raked-out joints shall be kept free from mortar and debris. Faces of units used in finished exposed areas shall be free from chipped edges, material texture or color defects or other imperfections distracting from the appearance of the finished work.

3.10.1 Surface Preparation

Surfaces on which masonry is to be laid shall be cleaned of laitance or other foreign material. No units having a film of water shall be laid.

3.10.2 Hot Weather Construction

Temperatures of masonry units and mortar shall not be greater than 50 degrees C when laid. Masonry erected when the ambient air temperature is more than 37 degrees C in the shade and when the relative humidity is less than 50 percent shall be given protection from the direct exposure to wind and sun for 48 hours after the installation.

3.10.3 Cold Weather Construction

Temperatures of masonry units and mortar shall not be less than 4 degrees C when laid. When the ambient air temperature is 0 degrees C or less, masonry veneer under construction shall be protected and maintained at a temperature greater than 0 degrees C for a period of 48 hours after installation. The proposed method of maintaining the temperature within the specified range shall be submitted for approval prior to implementation. No units shall be laid on a surface having a film of frost or water.

3.10.4 Tolerances

Masonry shall be laid plumb, level and true to line within the tolerances specified in TABLE 1. All masonry corners shall be square unless otherwise indicated on the drawings.

TABLE 1

| Variation From Plumb | |
|---|---|
| In adjacent units | 3 mm |
| In 3 m | 6 mm |

| | |
|---|---|
| In 6 m | 10 mm |
| In 12 m or more | 13 mm |

| Variation From Level Or Grades | |
|---|---|
| In 3 m | 3 mm |
| In 6 m | 6 mm |
| In 12 m or more | 13 mm |

| Variation From Linear Building Lines | |
|---|---|
| In 6 m | 13 mm |
| In 12 m or more | 19 mm |

| Variation From Cross Sectional Dimensions Of Walls | |
|---|---|
| Plus | 13 mm |
| Minus | 6 mm |

### 3.10.5 Mixing of Mortar

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Measurement of sand shall be accomplished by the use of a container of known capacity or shovel count based on a container of known capacity. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of the masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2 hours shall be discarded.

### 3.10.6 Cutting and Fitting

Wherever possible, full units shall be used in lieu of cut units. Where cut units are required to accommodate the design, cutting shall be done by masonry mechanics using power masonry saws. Wet-cut units shall be dried to the same surface-dry appearances of uncut units before being placed in the work. Cut edges shall be clean, true and sharp. Openings to accommodate pipes, conduits, and other accessories shall be neatly formed so that framing or escutcheons required will completely conceal the cut edges. Insofar as practicable, all cutting and fitting shall be accomplished while masonry work is being erected.

### 3.10.7 Masonry Units

When being laid, masonry units shall have suction sufficient to hold the mortar and to absorb water from the mortar, but shall be damp enough to allow the mortar to remain in a plastic state to permit the unit to be leveled and plumbed immediately after being laid without destroying bond.

Masonry units with frogging shall be laid with the frog side down and better or face side exposed to view. Masonry units that are cored, recessed or otherwise deformed may be used in sills or in other areas except where deformations will be exposed to view.

3.10.8 Mortar Joints

Mortar joint widths shall be uniform and such that the specified widths are maintained throughout. Joints shall be of thickness equal to the difference between the actual and nominal dimensions of the masonry units in either height or length but in no case shall the joints be less than 6 mm nor more than 13 mm wide. Joints shall be tooled slightly concave. Tooling shall be accomplished when mortar is thumbprint hard and in a manner that will compress and seal the mortar joint and produce joints of straight and true lines free of tool marks.

3.10.9 Joint Reinforcement

Unless otherwise shown, joint reinforcement shall be spaced at 400 mm on center vertically. Joint reinforcement shall not be placed in the same masonry course as veneer anchors unless the anchors are designed to accommodate the wire. Joint reinforcement shall be placed so that longitudinal reinforcing steel are centered in the veneer wythe for solid units. Longitudinal reinforcing steel shall be fully embedded in mortar for their entire length. Splices in joint reinforcement shall be lapped a minimum of 150 mm. Joint reinforcement must be discontinuous at all veneer joints. The minimum cover for joint reinforcement is 16 mm.

3.10.10 Veneer Joints

Concrete masonry veneer joints shall be provided at the locations shown on the drawings. Details of joints shall be as indicated on the drawings. Joints shall be clean and free of mortar and shall contain only backer rod and sealant, installed in accordance with Section 07900A JOINT SEALING. Horizontal reinforcement shall not extend through the joints.

3.10.11 Weep Holes

Weep holes shall be provided at all flashing locations at intervals of 600 mm. Weep holes shall be round plastic weep/vent tubing composed of medium-density polyethylene, 9 mm OD by 100 mm long. Cut flush with outside face of masonry. Weep holes shall be kept free of mortar and other obstructions.

3.10.12 Head Joint Vents

Head joint vents shall be provided near the top of the veneer wythe at the same spacing as the weep holes.

3.10.13 Discontinuous Work

When necessary to temporarily discontinue the work, masonry shall be stepped back for joining when work resumes. Toothing may be used only when specifically approved. Before resuming work, loose mortar shall be removed and the exposed joint shall be thoroughly cleaned. Top of walls subjected to rain or snow shall be covered with nonstaining waterproof covering or membrane when work is not in process. Covering shall extend a minimum of 600 mm down on each side of the wall and shall be held securely in place.

3.10.14 Cleaning

Mortar daubs or splashings shall be completely removed from finished exposed masonry surfaces before they harden or set up. Before completion of the work, defects in mortar joints shall be raked out as necessary, filled with mortar, and tooled to match the adjacent existing mortar in the joints. The proposed cleaning method shall be done on the sample wall panel and the sample panel shall be examined for discoloration or stain. If the sample panel is discolored or stained, the method of cleaning shall be changed to ensure that the masonry surfaces in the structure will not be adversely affected. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Cleaning shall be accomplished with the use of stiff bristle fiber brushes, wooden paddles, wooden scrapers, or other suitable nonmetallic tools. The exposed brick surfaces shall be saturated with water and cleaned with a proprietary brick cleaning agent recommended by the clay products manufacturer. The cleaning agent shall not adversely affect the brick masonry surfaces. Proprietary cleaning agents shall be used in conformance with the cleaning product manufacturer's printed recommendations. Efflorescence or other stains shall be removed in conformance with the recommendations of the masonry unit manufacturer. After construction and cleaning, masonry surfaces shall be left clean, free of mortar daubs, stain, and discolorations, including scum from cleaning operations, and will have tight mortar joints throughout. Metallic tools and brushes shall not be used for cleaning.

3.11 BUILDING EXPANSION JOINTS

Expansion joints shall be located where indicated and shall be of the size and details shown.

-- End of Section --

# SECTION 05120

## STRUCTURAL STEEL
**01/02**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC ASD Manual | (1989) Manual of Steel Construction Allowable Stress Design |
| AISC ASD/LRFD Vol II | (1992) Manual of Steel Construction Vol II: Connections |
| AISC Design Guide No. 10 | (1989) Erection Bracing of Low-Rise Structural Steel Frames |
| AISC FCD | (1995a) Quality Certification Program |
| AISC Pub No. S303 | (2000) Code of Standard Practice for Steel Buildings and Bridges |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 307 | (2000) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM A 325 | (2000) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A 325M | (2000) High-Strength Bolts for Structural Steel Joints (Metric) |
| ASTM A 36/A 36M | (2000a) Carbon Structural Steel |
| ASTM A 490 | (2000) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength |
| ASTM A 490M | (2000) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric) |

| | |
|---|---|
| ASTM A 500 | (1999) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A 501 | (1999) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 563M | (2000) Carbon and Alloy Steel Nuts (Metric) |
| ASTM A 6/A 6M | (2001) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A 992/A 992M | (2000) Steel for Structural Shapes For Use in Building Framing |
| ASTM F 844 | (2000) Washers, Steel, Plain (Flat), Unhardened for General Use |
| ASTM F 959M | (1999a) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Faxteners (Metric) |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A2.4 | (1998) Standard Symbols for Welding, Brazing and Nondestructive Examination |
| AWS D1.1 | (2000) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B46.1 | (1995) Surface Texture (Surface Roughness, Waviness, and Lay) |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 25 | (1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments) |

## 1.2 GENERAL REQUIREMENTS

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing, fabrication, and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of AISC ASD Manual AISC ASD/LRFD Vol. II. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. AISC ASD Manual and AISC ASD/LRFD Vol II shall govern the work. Welding shall be in accordance with AWS D1.1; except that welding for critical applications shall be in accordance with Section 05090A WELDING, STRUCTURAL or paragraph WELDING. High-strength bolting shall be in accordance with AISC ASD Manual.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Structural Steel System; G, ED.
Structural Connections; G, ED.

Shop and erection details including members (with their connections) not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with AWS A2.4.

SD-03 Product Data

Erection; G, ED.

Prior to erection, erection plan of the structural steel framing describing all necessary temporary supports, including the sequence of installation and removal shall be approved by a Registred Professional Engineer.

Welding; G, ED.

WPS not prequalified.

WPS prequalified.

SD-04 Samples

High Strength Bolts and Nuts.
Carbon Steel Bolts and Nuts.
Nuts Dimensional Style.
Washers.

Random samples of bolts, nuts, and washers as delivered to the job site if requested, taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

SD-07 Certificates

Mill Test Reports.

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items, including attesting that the structural steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified, prior to the installation.

Welder Qualifications.

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.1.

Welding Inspector.

Welding Inspector qualifications.

Fabrication.

A copy of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category.

## 1.4 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

## 1.5 WELDING INSPECTOR

Welding Inspector qualifications shall be in accordance with AWS D1.1

# PART 2 PRODUCTS

## 2.1 STRUCTURAL STEEL

### 2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to ASTM A 36/A 36M.

### 2.1.2 High-Strength Low-Alloy Steel

High-strength low-alloy steel shall conform to ASTM A 992/A 992M, Grade 345.

### 2.1.3 Structural Shapes for Use in Building Framing

Wide flange shapes in accordance with ASTM A 992/A 992M shall be used where indicated on the drawings.

## 2.2 STRUCTURAL TUBING

Structural tubing shall conform to ASTM A 500, Grade B .

## 2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 501 or ASTM A 53/A 53M, Type E or Type S, Grade B.

## 2.4 HIGH STRENGTH BOLTS AND NUTS

High strength bolts shall conform to ASTM A 325M , Type 1 with carbon steel nuts conforming to ASTM A 563M , Grade DH.

## 2.5 CARBON STEEL BOLTS AND NUTS

Carbon steel bolts shall conform to ASTM A 307, Grade A with carbon steel nuts conforming to ASTM A 563M , Grade A.

## 2.6 NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be Hex style when used with ASTM A 307 bolts or Heavy Hex style when used with ASTM A 325M bolts.

## 2.7 WASHERS

ASTM F 959M washers shall be used with all structural fasteners. Plain washers shall conform to ASTM F 844.

## 2.8 PAINT

Paint shall conform to SSPC Paint 25.

# PART 3 EXECUTION

## 3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC ASD Manual. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC FCD for Category 1 structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 13 micrometer as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M. Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed, and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting in accordance with AISC specification for Structural Steel Buildings and primed with the specified paint.

## 3.2 ERECTION

a: Erection of structural steel, except as indicated in item b. below, shall be in accordance with the applicable provisions of AISC ASD Manual. Erection plan shall be reviewed, stamped and sealed by a structural engineer licensed by the state in which the project is located.

b. {AM#0001}DELETED

### 3.2.1 Structural Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work. Field welded structural connections shall be completed before load is applied.

3.2.2 Base Plates and Bearing Plates

Column base plates for columns and bearing plates for beams, girders, and similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2.3 Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

3.3 WELDING

The contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including wleding done using prequalified procedures. Prequaliried procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for approval.

-- End of Section --

# SECTION 05500

# MISCELLANEOUS METAL
**01/02**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

| | |
|---|---|
| AA DAF-45 | (1997) Designation System for Aluminum Finishes |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI MH28.1 | (1982) Design, Testing, Utilization, and Application of Industrial Grade Steel Shelving |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 123/A 123M | (2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 36/A 36M | (2000a) Carbon Structural Steel |
| ASTM A 500 | (1999) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 924/A 924M | (1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM E 814 | (2000) Fire Tests of Through-Penetration Fire Stops |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1 | (2000) Structural Welding Code - Steel |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 10 | (1998; Errata 10-98-1) Portable Fire Extinguishers |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-344 | (Rev B) Lacquer, Clear Gloss, Exterior, Interior |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Miscellaneous Metal Items; G, ED.

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for the following items:

a. Access doors and frames.
b. Bollards.
c. Steel handrails and guardrails.
d. Steel stairs.
e. Expansion joint covers.
f. Shelving (all types).
g. Automatic door railings.
{AM#0001}<u>h. Downspout boots.</u>

SD-04 Samples

Miscellaneous Metal Items; G, ED.

Samples of the following items: Access doors and frames, shelving, and expansion joint covers. Samples shall be full size, taken from manufacturer's stock, and shall be complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

## 1.3 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123/A 123M, ASTM A 653/A 653M, or ASTM A 924/A 924M, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

## 1.4 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish.

## 1.5 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

## 1.6 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; and lag bolts and screws for wood.

## 1.7 ALUMINUM FINISHES

Unless otherwise specified, aluminum items shall have standard mill finish. The thickness of the coating shall be not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF-45. Items to be anodized shall receive a polished satin finish. Aluminum surfaces to be in contact with plaster or concrete during construction shall be protected with a field coat conforming to CID

A-A-344.

## 1.8 STAINLESS STEEL FINISHES

Stainless steel finish shall be #4.

## 1.9 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

# PART 2 PRODUCTS

## 2.1 ACCESS DOORS AND PANELS

Doors and panels shall be flush type unless otherwise indicated. Frames for access doors shall be fabricated of not lighter than 1.52 mm (16 gauge) steel with welded joints and finished with anchorage for securing into construction. Access doors shall be a minimum of 350 by 500 mm and of not lighter than 1.9 mm (14 gauge) steel, with stiffened edges, complete with attachments. Access doors shall be hinged to frame and provided with a flush face, screw driver operated latch. Exposed metal surfaces shall have a shop applied prime coat for field painting.

## 2.2 BOLLARDS

Bollards shall be heavy duty steel pipe conforming to ASTM A 53/A 53M, Type E or S, weight STD, black finish.

## 2.3 {AM#0001}DOWNSPOUT BOOTS

{AM#0001}Downspout boots shall be cast iron with one coat of rust inhibitive primer. Downspout boots shall be rectangular in cross section with rectangular receiving bells sized to fit downspouts and with four integral mounting brackets for attachment to exterior masonry wall. Provide appropriate outlet below grade to connect with underground storm drainage system. Product similar to (design basis) "McKinley" Type DS2 or DS4.

## 2.4 EXPANSION JOINT COVERS

Expansion joint covers shall be constructed of extruded aluminum with anodized satin finish for walls and ceilings and with standard mill finish for floor covers and exterior covers. Plates, backup angles, expansion filler strip and anchors shall be designed as indicated. Expansion joint system shall be rated and non-rated as shown on the drawings and provide a 50 mm movement.

## 2.5 HANDRAILS

Handrails shall be designed to resist a concentrated load of 890 N (200 pounds) in any direction at any point of the top of the rail or 292 Newtons per meter (20 pounds per foot) applied horizontally to top of the rail, whichever is more severe. Design shall conform to that shown on the Contract Drawings.

2.5.1 Steel Handrails, Including Carbon Steel Inserts

Steel handrails, including inserts in concrete, shall be steel pipe conforming to ASTM A 53/A 53M and structural tubing conforming to ASTM A 500, Grade A or B of equivalent strength Railings shall be shop painted.

a. Joint posts, rail, and corners shall be fabricated by one of the following methods:

(1) Mitered and welded joints by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight fitting interior sleeve not less than 150 mm long.

2.6 AUTOMATIC DOOR RAILINGS

Automatic door railings shall be of the size, design and location shown on the drawings. All components, including inserts and fasteners, shall be fabricated from stainless steel with #4 finish. Exposed fasteners are prohibited and all welds shall be ground smooth.

2.7 MISCELLANEOUS

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work.

2.8 SHELVING

Shelving shall conform to ANSI MH28.1 and shall be bolted and capable of resisting a uniform load of 363 kg per shelf. Minimum dimensions and number of shelves shall be as indicated.

2.9 STEEL STAIRS

Steel stairs shall be complete with structural channel stringers, metal pan cement-filled treads, landings, columns, handrails, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36/A 36M. Stairs and accessories shall be shop primed for field painting. Risers on stairs with metal pan treads shall be deformed to form a sanitary cove to retain the tread concrete.

2.10 FIRE EXTINGUISHER CABINETS

Cabinets to be located in fire-rated walls shall be fire-rated type, fabricated in accordance with ASTM E 814, and shall be listed by an approved testing agency for 1- and 2-hour combustible and non-combustible wall systems. The testing agency's seal shall be affixed to each fire-rated cabinet. Cabinets shall be of the recessed type suitable for 20 kg extinguishers. Box and trim shall be of heavy gage rolled steel. Door shall be a rigid frame with full length piano type hinge and double strength (DSA) glass panel. Door and panel shall have the manufacturer's standard white baked enamel finish inside and out.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed at the locations shown and according to the manufacturer's recommendations. Items listed below require additional procedures as specified.

### 3.2 REMOVABLE ACCESS PANELS

A removable access panel not less than 300 by 300 mm shall be installed directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

### 3.3 INSTALLATION OF BOLLARDS

Bollards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with, concrete having a compressive strength of 21 MPa.

### 3.4 {AM#0001}INSTALLATION OF DOWNSPOUT BOOTS

{AM#0001}Downspout boots shall be secured to building through integral lips with appropriate fasteners. Top of downspout boots shall be at elevation 101 200mm. Boots shall be installed plumb and true. Paint boots to match downspout color.

### 3.5 ATTACHMENT OF HANDRAILS

Brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints.

#### 3.5.1 Installation of Steel Handrails

Installation shall be as shown on the Contract Drawings.

### 3.6 INSTALLATION OF FIRE EXTINGUISHER CABINETS

Metal fire extinguisher cabinets shall be furnished and installed in accordance with NFPA 10 where shown on the drawings or specified. Exterior of door and frame shall be field painted to match wall color.

-- End of Section --

# SECTION 07416

## STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
**11/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI Cold-Formed Mnl | (1996) Cold-Formed Steel Design Manual |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 463/A 463M | (2000) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 792/A 792M | (1999) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process |
| ASTM C 1289 | (1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board |
| ASTM C 518 | (1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus |
| ASTM D 1308 | (1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes |
| ASTM D 1654 | (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments |
| ASTM D 1970 | (1997) Self-Adhering Polymer Modified Bituminous Sheet Materials Use as Steep Roofing Underlayment for Ice Dam Protection |
| ASTM D 2244 | (1995) Calculation of Color Differences from Instrumentally Measured Color |

| | |
|---|---|
| | Coordinates |
| ASTM D 2247 | (1999) Testing Water Resistance of Coatings in 100% Relative Humidity |
| ASTM D 2794 | (1993; R 1999el) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) |
| ASTM D 3359 | (1997) Measuring Adhesion by Tape Test |
| ASTM D 4214 | (1998) Evaluating Degree of Chalking of Exterior Paint Films |
| ASTM D 522 | (1993a) Mandrel Bend Test of Attached Organic Coatings |
| ASTM D 5894 | (1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet) |
| ASTM D 610 | (1995) Evaluating Degree of Rusting on Painted Steel Surfaces |
| ASTM D 714 | (1987; R 1994el) Evaluating Degree of Blistering of Paints |
| ASTM D 968 | (1993) Abrasion Resistance of Organic Coatings by Falling Abrasive |
| ASTM E 1592 | (1998) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference |
| ASTM E 84 | (2001) Surface Burning Characteristics of Building Materials |
| ASTM G 154 | (2000ael) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (1998) Minimum Design Loads for Buildings and Other Structures |

STEEL JOIST INSTITUTE (SJI)

| | |
|---|---|
| SJI Specs & Tables | (1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders |

1.2 GENERAL REQUIREMENTS

The Contractor shall furnish a commercially available roofing system which satisfies all requirements contained herein and has been verified by load testing and independent design analyses to meet the specified design requirements.

1.2.1 Roof Components and Layering

In general, the SSSMR system shall consist of the following components working from the metal roofing surface down to the metal deck. See drawings for complete descriptions:

Prefinished steel roofing panels on
Slip sheet on
Continuous ice and water barrier on
Thin layer of foil-faced rigid insulation on
Thick layer of unfaced rigid insulation on
Metal deck
Install triple layer of building felts between top of purlin and roofing panel as thermal break.

1.2.2 Structural Standing Seam Metal Roof (SSSMR) System

The SSSMR system covered under this specification shall include the entire roofing system; the standing seam metal roof panels, fasteners, purlins, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, ice and water barrier, slip sheet, rigid insulation, expansion joints, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents and curbs exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a complete and weathertight roof system.

1.2.3 Factory Rolling of Roof Panels

Roof panels shall be rolled in the factory using fully staged rollers. On-site rolling of roof panels is expressly prohibited.

1.2.4 Manufacturer

The SSSMR system shall be the product of a manufacturer who has been in the practice of manufacturing and designing SSSMR systems for a period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project.

1.2.5 Installer

The installer shall be certified by the SSSMR system manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

## 1.3 DESIGN REQUIREMENTS

The design of the SSSMR system shall be provided by the Contractor as a complete system. Members and connections not indicated on the drawings shall be designed by the Contractor. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

### 1.3.1 Design Criteria

Design criteria shall be in accordance with ASCE 7.

### 1.3.2 Dead Loads

The dead load shall be the weight of the SSSMR system. Collateral loads such as sprinklers, mechanical and electrical systems, and ceilings shall not be attached to the panels.

### 1.3.3 Live Loads

#### 1.3.3.1 Concentrated Loads

The panels and anchor clips shall be capable of supporting a 1335 N concentrated load. The concentrated load shall be applied at the panel midspan and will be resisted by a single standing seam metal roof panel assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

#### 1.3.3.2 Uniform Loads

The panels and concealed anchor clips shall be capable of supporting a minimum uniform live load of 960 Pa.

### 1.3.4 Roof Snow Loads

The design roof snow loads shall be as shown on the contract drawings.

### 1.3.5 Wind Loads

The design wind uplift pressure for the roof system shall be as shown on the contract drawings. The design uplift force for each connection assembly shall be that pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly. The safety factor listed below shall be applied to the design force and compared against the ultimate capacity. Prying shall be considered when figuring fastener design loads.

a. Single fastener in each connection.........3.0

b. Two or more fasteners in each connection...2.25

### 1.3.6 Thermal Loads

Roof panels shall be free to move in response to the expansion and contraction forces resulting from a total temperature range of 122 degrees C during the life of the structure.

1.3.7 Framing Members Supporting the SSSMR System

Any additions/revisions to framing members supporting the SSSMR system to accommodate the manufacturer/fabricator's design shall be the Contractor's responsibility and shall be submitted for review and approval. New or revised framing members and their connections shall be designed in accordance with SJI Specs & Tables. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180 of the span length.

1.3.8 Roof Panels Design

Steel panels shall be designed in accordance with AISI Cold-Formed Mnl. The structural section properties used in the design of the panels shall be determined using the unloaded shape of the roof panels. The calculated panel deflection from concentrated loads shall not exceed 1/180 of the span length. The calculated panel deflection under applied live load, or wind load shall not exceed 1/180 times the span length. Deflections shall be based on panels being continuous across three or more supports. Deflection shall be calculated and measured along the major ribs of the panels.

1.3.9 Accessories and Their Fasteners

Accessories and their fasteners shall be capable of resisting the specified design wind uplift forces and shall allow for thermal movement of the roof panel system. Exposed fasteners shall not restrict free movement of the roof panel system resulting from thermal forces. There shall be a minimum of two fasteners per clip. Single fasteners with a minimum diameter of 9 mm will be allowed when the supporting structural members are prepunched or predrilled.

1.4 PERFORMANCE REQUIREMENTS

The SSSMR shall be tested for wind uplift resistance in accordance with ASTM E 1592; SSSMR systems previously tested and approved by the Corps of Engineers' STANDARD TEST METHOD FOR STRUCTURAL PERFORMANCE OF SSMRS BY UNIFORM STATIC AIR PRESSURE DIFFERENCE may be acceptable. Two tests shall be performed. Test 1 shall simulate the edge condition with one end having crosswise restraint and other end free of crosswise restraint. The maximum span length for the edge condition shall be 750 mm. Test 2 shall simulate the interior condition with both ends free of crosswise restraint. The maximum span length for the interior condition shall be 1.5 m . External reinforcement, such as clamps on the ribs, shall not be installed to improve uplift resistance. Bolts through seams shall not be installed.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Drawings

Structural Standing Seam Metal Roof System; G, ED.

Metal roofing drawings and specifications and erection drawings; shop coating and finishing specifications; and other data as necessary to clearly describe design, materials, sizes, layouts, standing seam configuration, construction details, provisions for thermal movement, line of panel fixity, fastener sizes and spacings, sealants and erection procedures. Drawings shall reflect the intent of the architectural detailing using the manufacturer's proprietary products and fabricated items as required. The SSSMR system shop drawings shall be provided by the metal roofing manufacturer.

SD-03 Product Data

Design Analysis; G, ED.

Design analysis signed by a Registered Professional Engineer employed by the SSSMR manufacturer. The design analysis shall include a list of the design loads, and complete calculations for the support system (when provided by the Contractor), roofing system and its components; valley designs, gutter/downspout calculations, screw pullout test results, and shall indicate how expected thermal movements are accommodated.

Qualifications; G, ED.

Qualifications of the manufacturer and installer.

SD-04 Samples

Accessories; G, ED.

One sample of each type of flashing, trim, closure, thermal spacer block, cap and similar items. Size shall be sufficient to show construction and configuration.

Roof Panels; G, ED.

One piece of each type to be used, 225 mm long, full width.

Factory Color Finish; G, ED.

Three 75 by 125 mm samples of each type and color.

Fasteners; G, ED.

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation; G, ED.

One piece, 300 by 300 mm, of each type and thickness to be used, with a label indicating the rated permeance (if faced) and R-values. The flame spread, and smoke developed rating shall be shown on the label or provided in a letter of certification.

Gaskets and Insulating Compounds; G, ED.

Two samples of each type to be used and descriptive data.

Sealant; G, ED.

One sample, approximately 0.5 kg, and descriptive data.

Concealed Anchor Clips; G, ED.

Two samples of each type used.

Subpurlins; G, ED.

One piece, 225 mm long.

EPDM Rubber Boots; G, ED.

One piece of each type.

Ice and Water Shield; G, ED.

One piece, 200 mm by 200 mm.

SD-06 Test Reports

Test Report for Uplift Resistance of the SSSMR; G, ED.

The report shall include the following information:

a. Details of the SSSMR system showing the roof panel cross-section with dimensions and thickness.

b. Details of the anchor clip, dimensions, and thickness.

c. Type of fasteners, size, and the number required for each connection.

d. Purlins/subpurlins size and spacing used in the test.

e. Description of the seaming operation including equipment used.

f. Maximum allowable uplift pressures. These pressures are determined from the ultimate load divided by a factor of safety equal to 1.65.

g. Any additional information required to identify the SSSMR system tested.

h. Signature and seal of an independent registered engineer who witnessed the test.

SD-07 Certificates

Structural Standing Seam Metal Roof System; G, ED.

a. Certification that the actual thickness of uncoated sheets used in SSSMRS components including roofing panels, subpurlins, and concealed anchor clips complies with specified requirements.

b. Certification that materials used in the installation are mill certified.

c. Previous certification of SSSMR system tested under the Corps of Engineers' Standard Test Method in lieu of ASTM E 1592 testing.

d. Certification that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than three pieces has been tested and has met the quality standards specified for factory color finish.

e. Certification of installer. Installer certification shall be furnished.

f. Warranty certificates. Furnish samples of the 20-year Manufacturer's Material Warranties, the Manufacturer's 20-year System Weathertightness Warranty, and the 5-year bond required by the paragraph titled: Contractor's Weathertightness Warranty. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Structural Standing Seam Metal Roof (SSSMR) System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material Warranties, and the manufacturer's 20-year system weathertightness warranty.

Insulation.

Certificate attesting that the polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

## 1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry. Storage conditions shall provide good air circulation and protection from surface staining.

## 1.7 WARRANTIES

The SSSMR system shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

### 1.7.1 Contractor's Weathertightness Warranty

The SSSMR system shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty shall include the entire roofing system including, but not limited to, the standing seam metal roof panels, fasteners, purlins, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, ice and water barrier, slip sheet, rigid insulation, expansion joints, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents and curbs; exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a complete and weathertight roof system; and items specified in other sections of these specifications that are part of the SSSMR system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM, and shall start upon final acceptance of the facility. It is required that the Contractor provide a separate bond in an amount equal to the installed total roofing system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire SSSMR system as outlined above.

### 1.7.2 Manufacturer's Material Warranties.

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all SSSMR system components such as roof panels, anchor clips and fasteners, flashing, accessories, and trim, fabricated from coil material:

a. A manufacturer's 20 year material warranty warranting that the zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change color in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing with an air-drying version of the specified finish or replacing the defective coated material.

c. A roofing system manufacturer's 20 year system weathertightness warranty.

## 1.8 COORDINATION MEETING

A coordination meeting shall be held 30 days prior to the first submittal, for mutual understanding of the Structural Standing Seam Metal Roof (SSSMR) System contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roof system manufacturer, the roofing supplier, the erector, the SSSMR design engineer of record, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

# PART 2 PRODUCTS

## 2.1 ROOF PANELS

Panels shall be steel and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 16.7 m, which is approximate longest transportable panel length. When length of run exceeds 16.7 m and panel laps are provided, each sheet in the run shall extend over three or more supports. Width of sheets shall provide not more than 600 mm of coverage in place. SSSMR system shall have standing seams rolled during installation by an electrically driven seaming machine. Height of standing seams shall be not less than 50 mm for all seam types.

### 2.1.1 Steel Panels

Steel panels shall be zinc-coated steel conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 50 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Zinc, zinc-aluminum alloy or aluminum coated panels shall be 0.584 mm thick minimum. Panels shall be within 95 percent of reported tested thickness as noted in wind uplift resistance testing required in paragraph PERFORMANCE REQUIREMENTS.

### 2.1.2 Expansion Joints and Panel Connections

Expansion joints and panel connections shall be fabricated of steel and prefinished to match the roofing panels. Expansion joints and panel connections shall be the standard product of the manufacturer and shall allow for the anticipated building joint and roof panel movement. See drawings for details and locations.

## 2.2 CONCEALED ANCHOR CLIPS

Concealed anchor clips shall be the same as the tested roofing system. Clip bases shall have factory punched or drilled holes for attachment. Clips shall be made from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Single piece clips may be acceptable when the manufacturer can substantiate that the system can accommodate the thermal cyclic movement under sustained live or snow loads.

## 2.3 ACCESSORIES

Flashing, trim, metal closure strips, caps, gutters and downspouts, and similar metal accessories shall be the same metal type and thickness as the roof panels. Exposed metal accessories shall have the same finish systems as the roof panels. Die cast metal closures shall be installed with double bead tape sealant and fasteners that stitch the panel to a 2 mm preformed backer plate to ensure a positive compression of the tape sealant. The use of a continuous angle butted to the panel ends to form a closure will not be allowed.

## 2.4 FASTENERS

Fasteners for steel roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for structural connections shall provide both tensile and shear ultimate strengths of not less than 3340 N per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be sealed or have sealed washers on the exterior side of the roof to waterproof the fastener penetration. Washer material shall be compatible with the roofing; have a minimum diameter of 10 mm for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 3 mm thick. Exposed fasteners for factory color finished panels shall be factory finished to match the color of the panels.

### 2.4.1 Screws

Screws for attaching anchor devices shall be not less than No. 14. Actual screw pull out test results shall be performed for the actual material gage and yield strength of the structural purlins or subpurlins to which the clip is to be anchored/attached. Other screws shall be as recommended by the manufacturer to meet the strength design requirements of the panels.

2.4.2 Bolts

Bolts shall be not less than 6 mm diameter, shouldered or plain shank as required, with locking washers and nuts.

2.4.3 Structural Blind Fasteners

Blind screw-type expandable fasteners shall be not less than 6 mm diameter. Blind (pop) rivets shall be not less than 3 mm minimum diameter.

2.5 SUBPURLINS

Cold formed supporting structural members/subpurlins shall have a minimum thickness of 1.5 mm and a minimum tensile yield strength of 345 MPa. Hot rolled structural members shall have a minimum thickness of 6 mm and a minimum tensile yield strength of 248 MPa. Subpurlins shall be either galvanized or shop painted. See drawings for details.

2.6 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated on the drawings. The exterior coating shall be a nominal 0.025 mm thickness consisting of a topcoat of not less than 0.018 mm dry film thickness and the paint manufacturer's recommended primer of not less than 0.005 mm thickness. The interior color finish shall consist of a backer coat with a dry film thickness of 0.013 mm . The exterior color finish shall meet the test requirements specified below.

2.6.1 Salt Spray Test

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 2.0 to 3.0 mm failure at scribe, as determined by ASTM D 1654.

2.6.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 3 mm diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

2.6.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM G 154, test condition UVA-340 lamp, 8h UV at 60 degrees C followed by 4h CON at 45 degrees C {AM#0001}<u>for 4000 total hours</u>. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating with an adhesion rating less than 4B when tested in accordance with ASTM D

3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244.

2.6.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.6.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 13 mm diameter hemispherical head indenter, equal to 6.7 times the metal thickness in mm, expressed in Newton-meters, with no cracking.

2.6.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 50 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.6.7 Specular Gloss

Finished roof surfaces shall have a specular gloss value of "medium".

2.6.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

2.7 INSULATION

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 24 degrees C in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation shall have a flame spread not in excess of 75 and a smoke developed rating not in excess of 450 when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory. Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

2.7.1 Polyisocyanurate Rigid Board Insulation for Use Above a Roof Deck

Polyisocyanurate insulation shall conform to ASTM C 1289, Type II, (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For impermeable faced polyisocyanurate (Ex: aluminum foil), the maximum design R-value per 25 mm of insulation used shall be 0.98 square meter times degree K divided by watts (5.56 hours times square feet times degree F divided by BTU). Facings shall be non-asphaltic, glass fiber reinforced. Both faced and unfaced types shall be used per the drawings.

## 2.8 INSULATION RETAINERS

Insulation retainers shall be type, size, and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

## 2.9 SEALANT

Sealants shall be elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

## 2.10 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

## 2.11 SLIP SHEET

Slip sheet shall be a 0.24 kg per square meter rosin-sized, unsaturated building paper.

## 2.12 EPDM RUBBER BOOTS

Flashing devices around pipe penetrations shall be flexible, one-piece devices molded from weather-resistant EPDM rubber. Rubber boot material shall be as recommended by the manufacturer. The boots shall have base rings made of aluminum or corrosion resisting steel that conform to the contours of the roof panel to form a weather-tight seal.

## 2.13 ICE AND WATER BARRIER UNDERLAYMENT

Self-adhering ice and water barrier underlayment shall comply with ASTM D 1970 for roofing protection. Provide a high temperature resistant, rubberized underlayment such as Tamko "TW Metal and Tile Underlayment", GAF "Stormguard HT", or equal. See drawings for required locations at valleys and entire roof surface.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Molded closure strips shall be installed wherever roofing sheets terminate in open-end configurations, exclusive of flashings. The closure strip installation shall be weather-tight and sealed. Screws shall be installed with a clutching screw gun, to assure screws are not stripped. Field test shall be conducted on each gun prior to starting installation and periodically thereafter to assure it is adjusted properly to install particular type and size of screw as recommended by manufacturer's literature. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

### 3.1.1 {AM#0001}<u>Field Forming of Panels</u>

{AM#0001}<u>Field forming of panels will not be permitted.</u>

### 3.1.2 Subpurlins

Unless otherwise shown, subpurlins shall be anchored to the purlins or other structural framing members with bolts or screws. Attachment to the substrate (when provided) or to the panels is not permitted. The subpurlin spacing shall not exceed 750 mm on centers at the corner, edge and ridge zones, and 1500 mm maximum on centers for the remainder of the roof. Corner, edge, and ridge zones are as defined in ASCE 7.

### 3.1.3 Roof Panel Installation

Roof panels shall be installed with the standing seams in the direction of the roof slope. The side seam connections for installed panels shall be completed at the end of each day's work. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weather-tight installation. End laps of panels shall be provided in accordance with the manufacturer's instructions. Closures, flashings, EPDM rubber boots, roof curbs, and related accessories shall be installed according to the manufacturer's drawings. Fasteners shall not puncture roofing sheets except as provided for in the manufacturer's instructions for erection and installation. Expansion joints for the standing seam roof system shall be installed at locations indicated on the contract drawings and other locations indicated on the manufacturer's drawings. After installation, and before any panels are installed, purlins shall be checked with a stringline to insure they are in the same plane. Tolerances shall be in accordance with the panel manufacturer's recommendations. Purlins shall be shimmed, or building framing adjusted, as necessary to bring them into tolerance. {AM#0001}<u>The roofing manufacturer shall send their factory technical representative a minimum of five (5) times to the site to inspect</u>

the roofing installation for conformance with manufacturer's installation requirements. The timing of these trips shall be coordinated with the Contracting Officer's Representative (COR). A written report shall be given to the COR on each trip.

### 3.1.4 Concealed Anchor Clips

Concealed anchor clips shall be fastened directly to the structural framing members. Attachment to the substrate (when provided) or to the metal deck is not permitted. The maximum distance, parallel to the seams, between clips shall be 750 mm on center at the corner, edge, and ridge zones, and 1500 mm maximum on centers for the remainder of the roof.

## 3.2 INSULATION INSTALLATION

Insulation shall be continuous over entire roof surface. Where expansion joints, terminations, and other connections are made, the cavity shall be filled with batt insulation with vapor retarder providing equivalent R-value and perm rating as remaining insulation. Insulation shall be installed as indicated and in accordance with manufacturer's instructions.

### 3.2.1 Board Insulation

Rigid or semirigid board insulation shall be laid in close contact. Board shall be attached to the metal roof deck with bearing plates and fasteners, as recommended by the insulation manufacturer, so that the insulation joints are held tight against each other, and shall have a minimum of 1 fastener per 0.37 square meters. Layout and joint pattern of insulation and fasteners shall be indicated on the shop drawings. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer.

## 3.3 SLIP SHEET INSTALLATION

A slip sheet shall be laid over the blanket insulation facing to prevent the vinyl facing from adhering to the metal roofing.

## 3.4 CLEANING AND TOUCH-UP

Exposed SSSMR systems shall be cleaned at completion of installation. Debris that could cause discoloration and harm to the panels, flashings, closures and other accessories shall be removed. Grease and oil films, excess sealants, and handling marks shall be removed and the work shall be scrubbed clean. Exposed metal surfaces shall be free of dents, creases, waves, warps, buckles, fastening stresses, and distortions. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Factory color finished surfaces shall be touched up with the manufacturer's recommended touch up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

FACILITY DESCRIPTION________________________________________________

BUILDING NUMBER:____________________________________________________

CORPS OF ENGINEERS CONTRACT NUMBER:__________________________________

CONTRACTOR

CONTRACTOR:_________________________________________________________

ADDRESS:____________________________________________________________

POINT OF CONTACT:___________________________________________________

TELEPHONE NUMBER:___________________________________________________

OWNER

OWNER:______________________________________________________________

ADDRESS:____________________________________________________________

POINT OF CONTACT:___________________________________________________

TELEPHONE NUMBER:___________________________________________________

CONSTRUCTION AGENT

CONSTRUCTION AGENT:_________________________________________________

ADDRESS:____________________________________________________________

POINT OF CONTACT:___________________________________________________

TELEPHONE NUMBER:___________________________________________________

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

THE SSSMR SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY _____________________________ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, PURLINS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH ASTM E 1592. IN ADDITION, THE SYSTEM PANEL FINISHES, ICE AND WATER SHIELD, SLIP SHEET, RIGID AND BATT INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS AND CURBS; EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A COMPLETE AND WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE SSSMR SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON ____________________________ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

____________________________________________________________
(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE SSSMR SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE SSSMR SYSTEM DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE SSSMR SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

**

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

**REPORTS OF LEAKS AND SSSMR SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE SSSMR SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, THE PARTIES SHALL, WITHIN TEN (10) DAYS, JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

# SECTION 07840

# FIRESTOPPING
**08/00**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM E 84 | (2001) Surface Burning Characteristics of Building Materials |
| ASTM E 119 | (2000) Fire Tests of Building Construction and Materials |
| ASTM E 814 | (2000) Fire Tests of Through-Penetration Fire Stops |
| ASTM E 1399 | (1997) Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 723 | (1996; Rev thru Dec 1998) Test for Surface Burning Characteristics of Building Materials |
| UL 1479 | (1994; Rev thru Feb 1998) Fire Tests of Through-Penetration Firestops |
| UL 2079 | (1998) Tests for Fire Resistance of Building Joint Systems |
| UL Fire Resist Dir | (1999) Fire Resistance Directory (2 Vol.) |

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials.

Detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resist Dir or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgement, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than 5 penetrations or construction joints are to receive firestopping, drawings shall indicate location and type of application.

SD-07 Certificates

Firestopping Materials.

Certificates attesting that firestopping material complies with the specified requirements. In lieu of certificates, drawings showing UL classified materials as part of a tested assembly may be provided. Drawings showing evidence of testing by an alternate nationally recognized independent laboratory may be substituted.

Installer Qualifications.

Documentation of training and experience.

Inspection.

Manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements. Include an annotated floor plan designating areas inspected and dates inspected.

## 1.3 GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing tested and listed firestop systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions and floors including through-penetrations and construction joints and gaps.
Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof

or floor deck above.

## 1.4 STORAGE AND DELIVERY

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

## 1.5 INSTALLER QUALIFICATIONS

The Contractor shall engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures.

## 1.6 COORDINATION

The specified work shall be coordinated with other trades. Firestopping materials, at penetrations of pipes and ducts, shall be applied prior to insulating, unless insulation meets requirements specified for firestopping. Firestopping materials at building joints and construction gaps shall be applied prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible.

# PART 2 PRODUCTS

## 2.1 FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured, asbestos-free products complying with the following minimum requirements:

### 2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resist Dir or by a nationally recognized testing laboratory.

### 2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application.

### 2.1.3 Fire Resistance Rating

Firestopping {AM#0001}shall have a {AM#0001} fire resistance rating {AM#0001} equal to or greater than that of the assembly in which it is being placed.

2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479. Fire resistance ratings shall be as follows:

a. Penetrations of Fire Resistance Rated Walls, Partitions and Floors : F Rating = Rating of wall or partition being penetrated.

2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph GENERAL REQUIREMENTS, and gaps such as those between floor slabs or roof decks and curtain walls shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested per ASTM E 119 or UL 2079 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E 1399 or UL 2079.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device.

3.2 INSTALLATION

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping shall be installed in accordance with manufacturer's written instructions. Tested and listed firestop systems shall be provided in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls and partitions.

b. Penetrations of vertical shafts such as pipe chases and elevator shafts.

c. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

d. Construction joints in fire rated walls and partitions.

e. Other locations where required to maintain fire resistance rating of the construction.

### 3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Thermal insulation shall be replaced with a material having equal thermal insulating and firestopping characteristics.

### 3.2.2 Fire Dampers

Fire dampers shall be installed and firestopped in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 3.3 INSPECTION

Firestopped areas shall not be covered or enclosed until inspection is complete and approved. A manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. The manufacturer's representative shall inspect all firestopping and annotate a floor plan showing areas and dates that the inspection occurred.

-- End of Section --

# SECTION 08110

# STEEL DOORS AND FRAMES
**05/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI A250.6 | (1997) Hardware on Standard Steel Doors (Reinforcement - Application) |
| ANSI A250.8 | (1998) SDI-100 Recommended Specifications for Standard Steel Doors and Frames |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 591 | (1998) Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 924/A 924M | (1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM C 578 | (1995) Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM C 591 | (1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C 612 | (2000) Mineral Fiber Block and Board Thermal Insulation |
| ASTM D 2863 | (1997) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index) |

DOOR AND HARDWARE INSTITUTE (DHI)

| | |
|---|---|
| DHI A115 | (1991) Steel Door Preparation Standards (Consisting of A115.1 through A115.6 and A115.12 through A115.18) |

HOLLOW METAL MANUFACTURERS ASSOCIATION (HMMA)

| | |
|---|---|
| HMMA HMM | (1992) Hollow Metal Manual |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 80 | (1999) Fire Doors and Fire Windows |
| NFPA 252 | (1999) Standard Methods of Fire Tests of Door Assemblies |

STEEL DOOR INSTITUTE (SDOI)

| | |
|---|---|
| SDI 105 | (1998) Recommended Erection Instructions for Steel Frames |
| SDI 113 | (1979) Apparent Thermal Performance of STEEL DOOR and FRAME ASSEMBLIES |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 10B | (1997) Fire Tests of Door Assemblies |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Doors; G, ED.

Frames; G, ED.

Accessories; G, ED.

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Schedule of doors; G, ED.

Schedule of frames; G, ED.

Submit door and frame locations.

SD-03 Product Data

Doors.

Frames.

Accessories

Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction, panel (internal) reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data sufficient for comparison to ANSI A250.8 requirements.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 6 mm airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

# PART 2 PRODUCTS

## 2.1 STANDARD STEEL DOORS

ANSI A250.8, except as specified otherwise. Prepare doors to receive hardware specified in Section 08710, "Door Hardware." Undercut where indicated. Exterior doors shall have top edge closed flush and sealed to prevent water intrusion. Doors shall be 44.5 mm thick, unless otherwise indicated.

### 2.1.1 Classification - Level, Performance, Model

#### 2.1.1.1 Heavy Duty Doors

ANSI A250.8, Level 2, physical performance Level B, Model 2, with core construction as required by the manufacturer for interior doors , of size(s) and design(s) indicated. Where vertical stiffener cores are required, the space between the stiffeners shall be filled with mineral board insulation. Provide Level II throughout project interior.

#### 2.1.1.2 Maximum Duty Doors

ANSI A250.8, Level 4, physical performance Level A, Model 2 with core construction as required by the manufacturer for exterior doors, of size(s) and design(s) indicated. Where vertical stiffener cores are required, the space between the stiffeners shall be filled with mineral board insulation. Provide Level 4 throughout project exterior.

## 2.2 CUSTOM HOLLOW METAL DOORS (OPTION)

Provide custom hollow metal doors where nonstandard steel doors are indicated. At the Contractor's option, custom hollow metal doors may be provided in lieu of standard steel doors. Door size(s), design, materials, construction, gages, and finish shall be as specified for standard steel doors and shall comply with the requirement of HMMA HMM. Fill all spaces in doors with insulation. Close top and bottom edges with steel channels not lighter than 1.5 mm thick. Close tops of exterior doors flush with an additional channel and seal to prevent water intrusion. Prepare doors to receive hardware specified in Section {AM#0001} 08700, "Door Hardware." Undercut doors where indicated. Doors shall be 44.5 mm thick, unless otherwise indicated.

## 2.3 ACCESSORIES

### 2.3.1 Louvers

Louvers in doors are prohibited.

### 2.3.2 Moldings

Provide moldings around glass of interior and exterior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Muntins shall interlock at intersections and shall be fitted and welded to stationary moldings.

## 2.4 INSULATION CORES

All exterior doors shall be insulated. Insulated cores shall be of type specified, and provide an apparent U-factor of .48 in accordance with SDI 113 and shall conform to:

a. Rigid Polyurethane Foam: ASTM C 591, Type 1 or 2, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D 2863; or

b. Rigid Polystyrene Foam Board: ASTM C 578, Type I or II; or

c. Mineral board: ASTM C 612, Type I.

## 2.5 STANDARD STEEL FRAMES

ANSI A250.8, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners. Provide steel frames for doors, transoms, sidelights, mullions, cased openings, and interior glazed panels, unless otherwise indicated.

### 2.5.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

### 2.5.2 Mullions and Transom Bars

Mullions and transom bars shall be closed or tubular construction and shall member with heads and jambs butt-welded thereto . Bottom of door mullions shall have adjustable floor anchors and spreader connections.

### 2.5.3 Stops and Beads

Form stops and beads from 0.9 mm thick steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 300 to 400 mm on centers. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

### 2.5.4 Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

### 2.5.5 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 1.2 mm thick.

#### 2.5.5.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 2285 mm in height, provide one additional anchor for each jamb for each additional 760 mm or fraction thereof.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 5 mm diameter steel wire, adjustable or T-shaped;

b. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding.

## 2.6 FIRE DOORS AND FRAMES

NFPA 80 and this specification. The requirements of NFPA 80 shall take precedence over details indicated or specified.

### 2.6.1 Labels

Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10B. Labels shall be metal with raised letters, and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames and to the hinge edge of the door. Door labels shall not be painted.

### 2.6.2 Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

2.6.3 Astragal on Fire Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.

2.7 WEATHERSTRIPPING

As specified in Section 08710, "Door Hardware."

2.8 HARDWARE PREPARATION {AM#0001}FOR NON-RATED ASSEMBLES

Provide minimum hardware reinforcing gages as specified in ANSI A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of ANSI A250.8 and ANSI A250.6. For additional requirements refer to DHI A115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of ANSI A250.8, as applicable. Punch door frames, with the exception of frames that will have weatherstripping or soundproof gasketing, to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.8.1 {AM#0001}Hardware Preparation for Fire-Rated Assemblies

{AM#0001}Fire-rated doors and frames shall not be altered once they have been delivered from the factory.

2.9 FINISHES

2.9.1 Factory-Primed Finish

All surfaces of doors and frames shall be thoroughly cleaned, chemically treated and factory primed with a rust inhibiting coating as specified in ANSI A250.8. Provide for all interior doors.

2.9.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate exterior doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A 924/A 924M and ASTM A 653/A 653M. The Coating weight shall meet or exceed the minimum requirements for coatings having 122 grams per square meter, total both sides, i.e., ZF120. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in ANSI A250.8. Provide for all exterior doors.

2.9.3 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A 591, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in ANSI A250.8.

### 2.10 FABRICATION AND WORKMANSHIP

Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable.

#### 2.10.1 Grouted Frames

For frames to be installed in exterior walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Frames

Set frames in accordance with SDI 105. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. Backfill frames in masonry walls with mortar. When an additive is provided in the mortar, coat inside of frames with corrosion-inhibiting bituminous material. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed.

#### 3.1.2 Doors

Hang doors in accordance with clearances specified in ANSI A250.8. After erection and glazing, clean and adjust hardware.

#### 3.1.3 Fire Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80.

### 3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

### 3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

## 3.4 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

| PRODUCTS | INCH-POUND | METRIC |
|---|---|---|
| Door thickness | 1 3/4 inches | 44.5 mm |
| Steel channels | 16 gage | 1.5 mm |
| Steel Sheet | 23 gage | 0.7 mm |
| | 16 gage | 1.5 mm |
| | 20 gage | 0.9 mm |
| | 18 gage | 1.2 mm |
| Anchor bolts | 3/8 inches | 10 mm |

-- End of Section --

# SECTION 08700

## BUILDERS' HARDWARE
**03/96**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM E 283 | (1991) Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen |
| ASTM F 883 | (1997) Padlocks |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| BHMA L & R Directory | (Effective thru Jun 1999) Directory of Certified Locks & Latches |
| BHMA Closer Directory | (Effective thru Jul (1999) Directory of Certified Door Closers |
| BHMA Exit Devices Directory | (Effective thru Aug 1998) Directory of Certified Exit Devices |
| BHMA A156.1 | (1997) Butts and Hinges |
| BHMA A156.2 | (1996) Bored and Preassembled Locks and Latches |
| BHMA A156.3 | (1994) Exit Devices |
| BHMA A156.4 | (1992) Door Controls - Closers |
| BHMA A156.5 | (1992) Auxiliary Locks & Associated Products |
| BHMA A156.6 | (1994) Architectural Door Trim |
| BHMA A156.7 | (1997) Template Hinge Dimensions |

| | |
|---|---|
| BHMA A156.8 | (1994) Door Controls - Overhead Stops and Holders |
| BHMA A156.13 | (1994) Mortise Locks & Latches |
| BHMA A156.16 | (1989) Auxiliary Hardware |
| BHMA A156.18 | (1993) Materials and Finishes |
| BHMA A156.19 | (1997) Power Assist and Low Energy Power Operated Doors |
| BHMA A156.21 | (1996) Thresholds |
| BHMA A156.23 | (1992) Electromagnetic Locks |

DOOR AND HARDWARE INSTITUTE (DHI)

| | |
|---|---|
| DHI Keying Systems | (1989) Keying Systems and Nomenclature |
| DHI Locations for CSD | (1997) Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames |
| DHI Locations for SSD | (1990) Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames |
| DHI ANSI/DHI A115.1G | (1994) Installation Guide for Doors and Hardware |
| DHI ANSI/DHI A115-W | (Varies) Wood Door Hardware Standards (Incl All5-W1 thru A115-W9) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 80 | (1999) Fire Doors and Fire Windows |
| NFPA 101 | (2000) Life Safety Code |
| NFPA 105 | (1999) Installation of Smoke-Control Door Assemblies |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Exit Devices; G, ED.
Drawings; G, ED

Detail drawings for hardware devices for keyless push button access control systems, and other electrical hardware devices showing complete wiring and schematic diagrams and other details required to demonstrate proper function of units.

SD-03 Product Data

Hardware and Accessories; G, ED.

Manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions. Spare parts data for locksets, exit devices, closers, power operators, electro-magnetic locks after approval of the detail drawings, and not later than 1 month prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Hardware Schedule; G, ED.

Hardware schedule listing all items to be furnished. The schedule shall include for each item: the quantities; manufacturer's name and catalog numbers; the ANSI number specified, sizes; detail information or catalog cuts; finishes; door and frame size and materials; location and hardware set identification cross-references to drawings; lock trim material thicknesses; lock trim material evaluation test results; corresponding reference standard type number or function number from manufacturer's catalog if not covered by ANSI or BHMA; and list of abbreviations and template numbers.

Keying; G, ED.

Keying schedule developed in accordance with DHI Keying Systems, after the keying meeting with the user.

SD-04 Samples

Locksets; G, ED.

Furnish a sample of the locksets to be furnished this project. Notify the Contracting Officer and base personnel for a meeting demonstrating that the locksets to be furnished are fully compatible with the existing keying system. An existing base core, and key will be fitted to the sample lockset. The core shall fit the lockset without the use of adaptors and without play. The key shall easily lock and unlock the lockset without binding or other difficulties. Control key shall easily remove and install cores.

SD-07 Certificates

Hardware and Accessories; G, ED.

The hardware manufacturer's certificates of compliance stating that the supplied material or hardware item meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of the product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. A statement that the proposed hardware items appear in BHMA L & R Directory, BHMA Closer Directory and BHMA Exit Devices Directory directories of certified products may be submitted in lieu of certificates.

Furnish a separate certificate of compliance attesting that hardware items comform to the Section 00700 Contract clauses pertaining to the Buy American Act.

## 1.3 PREDELIVERY CONFERENCE

Upon approval of the Hardware Schedule, the construction Contractor shall arrange a conference with the hardware supplier, Contracting Officer and the using agency to determine keying system requirements. Location of the key control storage system, set-up and key identification labeling will also be determined.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Hardware shall be delivered to the project site in the manufacturer's original packages. Each article of hardware shall be individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule. Each change key shall be tagged or otherwise identified with the door for which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and on the hardware schedule. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.

## 1.5 SPECIAL TOOLS

Special tools, such as those supplied by the manufacturer, unique wrenches, and dogging keys, shall be provided as required to adjust hardware items.

## 1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

## 1.7 OPERATION AND MAINTENANCE MANUALS

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided. The instructions for power operators and electromagnetic locks shall include simplified diagrams as installed.

# PART 2 PRODUCTS

## 2.1 GENERAL HARDWARE REQUIREMENTS

Hardware shall conform to the requirements specified herein and the HARDWARE SETS listing at the end of this section. Hardware set numbers correspond to the set numbers shown on the drawings.

## 2.2 TEMPLATES

Requirements for hardware to be mounted on metal doors or metal frames shall be coordinated between hardware manufacturer and door or frame manufacturer by use of templates and other information to establish location, reinforcement required, size of holes, and similar details. Templates of hinges shall conform to BHMA A156.7.

## 2.3 HINGES

Hinges shall conform to BHMA A156.1. Hinges used on metal doors and frames shall also conform to BHMA A156.7. Except as otherwise specified, hinge sizes shall conform to the hinge manufacturer's printed recommendations.

### 2.3.1 Hinges for Reverse Bevel Doors with Locks

Hinges for reverse bevel doors with locks shall have pins that are made nonremovable by means such as a set screw in the barrel, or safety stud, when the door is in the closed position.

### 2.3.2 Contractor's Option

Hinges with antifriction bearings may be furnished in lieu of ball bearing hinges, except where prohibited for fire doors by the requirements of NFPA 80.

### 2.3.3 Pivot Hinges

Pivot hinges shall conform to BHMA A156.4.

### 2.3.4 {AM#0001}Spring Hinges

{AM#0001}Spring hinges shall conform to BHMA A156.17.

### 2.3.5 Electric Hinges

Electric hinges shall conform to BHMA A156.1 with modification of added electric wires to insure correct operation of electric hardware items.

## 2.4 LOCKS AND LATCHES

To the maximum extent possible, locksets, latchsets and deadlocks, and all components thereof, including cylinders and removable cores, shall be the products of a single manufacturer. Strikes for pairs of wood doors shall be furnished with wrought boxes. {AM#0001}All parts, such a strike, latchbolt, shall match finish of lever handle and trim.

### 2.4.1 Mortise Lock and Latchsets

Mortise lock, latchsets, and strikes shall be series 1000 and shall conform to BHMA A156.13, operational Grade 1. Mortise type locks and latches for doors 44 mm thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door. Mortise locks shall have armored fronts.

2.4.2 Bored Lock and Latchsets

Bored lock, latchsets, and strikes shall be series 4000 and shall conform to BHMA A156.2, Grade 1. Bored type locks and latches for doors 35 mm thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door.

2.4.3 Auxiliary Locks and Associated Products

Mortise dead locks shall conform to BHMA A156.5. Bolt retraction shall be dead bolt style. Strike boxes shall be furnished with dead bolt and latch strikes for Grade 1.

2.4.4 Lock Cylinders (Mortise, Rim and Bored)

Lock cylinders shall comply with BHMA A156.5. Lock cylinder shall have not less than seven pins {AM#0001}<u>and shall have a "K" or "L" type keyway</u>. Cylinders shall have key removable type cores. {AM#0001}<u>Cores shall be pinned for an A-3 (.018 differental) type system.</u> A grand master keying system shall be provided{AM#0001}<u>as an</u> extension of the existing {AM#0001}<u>Base Master</u> keying system {AM#0001}______. Cylinders and cores shall be compatible with existing locks that were manufactured by Best Lock Corporation to extend the existing Base Keying System. {AM#0001}<u>Locks shall be furnished with manufacturer's standard</u> construction interchangeable cores {AM#0001}<u>and key system.</u> Disassembly of knob or lockset shall not be required to remove core from lockset. All locksets, lockable exit devices, and padlocks shall accept same interchangeable cores.

2.4.5 Padlocks

Padlocks shall conform to ASTM F 883, Type PO1, Option B, Grade 6. All padlocks shall be keyed into master key system.

2.4.6 Lock Trim

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement of BHMA A156.2 or BHMA A156.13, knobs, lever handles, roses, and escutcheons shall be 1.27 mm thick, if unreinforced. If reinforced, the outer shell shall be 0.89 mm thick and the combined thickness shall be 1.78 mm except that knob shanks shall be 1.52 mm thick. Knob diameter shall be 54 to 57 mm. Lever handles shall be of plain design with ends returned to no more than 10 mm from the door face.

2.4.7 Electromagnetic Locks

Electromagnetic locks shall allow for locking or unlocking of doors from a remote location by means of recessed wall switch with hinged cover.

Electromagnetic locks shall be fail safe (unlocked when power is off) and shall conform to BHMA A156.23.

## 2.5 EXIT DEVICES AND EXIT DEVICE ACCESSORIES

Exit devices and exit device accessories shall conform to BHMA A156.3, Grade 1.

### 2.5.1 Exit Devices and Auxiliary Items

Trim shall be of wrought construction and commercial plain design with straight, beveled, or smoothly rounded sides, corners, and edges. Adjustable strikes shall be provided for rim type and vertical rod devices. Open back strikes shall be provided for pairs of doors with mortise and vertical rod devices; except open back strikes shall be used on labeled doors only where specifically provided for in the published listings. Touch bars shall be provided in lieu of conventional crossbars and arms. Escutcheons shall be provided not less than 175 by 55 mm. Escutcheons shall be cut to suit cylinders and operating trim.

### 2.5.2 Door Coordinator

Door coordinator with carry bar shall be Type 21 and shall be provided for each pair of doors equipped with an overlapping astragal. The coordinator shall be mechanically operated and shall be capable of holding the active door of a pair open until the inactive door has preceded it in the closing cycle. When used as fire exit hardware, the coordinator and carry bar shall be listed or labeled by a nationally recognized independent testing laboratory.

### 2.5.3 Automatic Flush Bolts

Automatic flush bolts shall be Type 25 in accordance with BHMA A156.3, and shall be installed at the top and bottom of the inactive leaf of pairs of doors where specified in the hardware sets. Flush bolts shall be mortised in the strike edge of the door.

## 2.6 KEYING

Locks shall be keyed in sets or subsets in accordance with the approved schedule. Locks shall be furnished with the manufacturer's standard construction cores and key system. Permanent cylinders, cores, and keys shall be sent by the {AM#0001} lock manufacturer directly to Dyess Air Force Base by registered mail or other approved means{AM#001} . {AM#0001} T he address is:

7th {AM#0001} CES/CEOL2
{AM#0001} Attn: Locksmith
{AM#0001}718 Third Street
Dyess {AM#0001} AFB, TX 79607-{AM#0001}1618

{AM#0001} Keys for locks shall be stamped with change number and the inscription "U.S. Property - Do Not Duplicate." Keys shall be supplied as follows:

| | |
|---|---|
| Locks: | 2 change keys each lock. |
| Master keyed sets: | {AM#0001} 6 keys each set. |
| Grand master keys: | 4 total. |
| Construction keys: | 6 total. |
| Blank keys: | {AM#0001} one per lockset provided. |
| {AM#0001}A3 Key kit: | {AM#0001}1 Kit for each 100 locksets (or fraction thereof) |

The keys shall be furnished to the Contracting Officer arranged in a container {AM#0001} specifically designed for key control system storage in sets or subsets as scheduled.

## 2.7 DOOR CLOSING DEVICES

Door closing devices shall conform to BHMA A156.4, Grade 1. Closing devices shall be products of one manufacturer for each type specified. The opening resistance of closing devices shall not exceed 67 N applied at the latch stile or exceed 22 N where low opening resistance is scheduled.

### 2.7.1 Surface Type Closers

Surface type closers shall be Grade 1, Series C02000 Standard Cover with options PT-4H, Size 1 or 2 through Size 6, and PT-4D with back check position valve. Except as otherwise specified, sizes shall conform to the manufacturer's published recommendations. Closers for outswinging exterior doors shall have parallel arms or shall be top jamb mounted. Closers for doors close to a wall shall be of narrow projection so as not to strike the wall at the 90-degree open position. Closers on doors accessible to the physically handicapped (schedule with low opening resistance) shall have the closing force set for a push-pull of 2.27 kg (5 pounds) applied at the handle for interior doors; for exterior doors, set to the minimum required to relatch the door.

### 2.7.2 Floor Closers and Pivots

Floor closers shall be Grade 1 with internal dead stop. Floor closers shall have cement boxes. Pivots used on doors with floor closers shall be of the same manufacturer as the floor closers. Floor closers shall have independent latch and sweep speed adjusting valves, backcheck, mechanical selective hold-open , and optional delayed action. Setting tools shall be furnished for use in installing floor closers.

## 2.8 DOOR CONTROLS - OVERHEAD HOLDERS AND STOPS

Door controls - overhead holders and stops shall conform to BHMA A156.8.

## 2.9 POWER ASSIST AND LOW ENERGY POWER OPERATORS

Power assist and low energy power operators, controls and signage shall conform to BHMA A156.19. Operators shall be electrically operated.

## 2.10 AUTOMATIC DOOR OPERATORS

Automatic door operators, controls and signage shall conform to BHMA A156.10 Operators shall be electrically operated. For pairs of doors provide multiple sensors as required to provide activating and safety detection zones required by BHMA A156.10.

2.11 ARCHITECTURAL DOOR TRIM

Architectural door trim shall conform to BHMA A156.6.

2.11.1 Door Protection Plates

2.11.1.1 Armor Plates

Armor plates shall be Type {AM#0001}J101 stainless steel, 900 mm in height, and 50 mm less in width than the width of the door for single doors and 25 mm less for pairs of doors. Edges of metal plates shall be beveled.

2.11.1.2 Kick Plates

Kick plates shall be Type J102 stainless steel. Width of plates shall be 50 mm less than door width for single doors and 25 mm less for pairs of doors. Height shall be 250 mm, except where the bottom rail is less than 250 mm the plate shall extend to within 13 mm of the panel mold or glass bead. Edges of plates shall be beveled.

2.11.2 Door Edge Guards

Door edge guards shall be furnished to protect door edges with the required cut-outs for hardware items such as hinges, flush bolts, and locks. Door edge guards shall satisfy fire door ratings. Door edge guards shall be Type 1.27 mm thick stainless steel.

2.11.3 Push Plates

2.11.3.1 Combination Push-Pull Plates

Combination push-pull plates shall be Type J303, 1.27 mm thick minimum stainless steel beveled four edges.

2.11.3.2 Flat Plates

Flat plates shall be Type J301 1.27 mm thickstainless steel , size 102 mm by 406 mm. Edges of plates shall be beveled.

2.11.4 Door Pulls and Push/Pull Units

2.11.4.1 Door Pulls

Door pulls shall be Category J400 stainless steel of plain modern design. Pulls shall be Type J405 thru-bolted to Type J301 flat push plates.

2.11.5 Push Bars

Push bars shall be Category J500, stainless steel. Edges of mounting plates shall be beveled.

## 2.12 AUXILIARY HARDWARE

Auxiliary hardware, consisting of flush bolts, dust-proof strikes and door stops,, shall conform to BHMA A156.16. Lever extension flush bolts shall be Type L14081. Dust-proof strikes shall be Type L04011 for doors that are not fire rated. Dust-proof strikes shall be Type L04021 for fire rated doors. Other auxiliary hardware of the types listed below, shall conform to BHMA A156.16.

Coat Hook: L03111 X 626
Install on back of office doors.

## 2.13 MISCELLANEOUS

### 2.13.1 Automatic Door Bottoms

Automatic door bottoms shall be surface type with aluminum housing cover, anodized clear finish. Door bottom shall have a wool, felt, rubber, vinyl, or neoprene seal and shall be actuated by the opening and closing of the door. The door bottom shall exclude light when the door is in the closed position and shall inhibit the flow of air through the unit.

### 2.13.2 Metal Thresholds

Thresholds shall conform to BHMA A156.21. Thresholds for exterior doors shall be extruded aluminum of the type indicated and shall provide proper clearance and an effective seal with specified weather stripping. Latching thresholds shall be of such height that the bottom of the door shall be 3 mm over the tread of the threshold and 3 mm below the top of the stop. Where required, thresholds shall be modified to receive projecting bolts of flush bolts and exit devices. Thresholds for doors accessible to the handicapped shall be beveled with slopes not exceeding 1:2 and with heights not exceeding 13 mm. Air leakage rate of weatherstripping shall not exceed 0.775 liters per second per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

### 2.13.3 Rain Drips

Extruded aluminum, not less than 1.78 mm thick, bronze anodized. Door sill rain drips shall be 38 mm to 44 mm high by 16 mm projection. Overhead rain drips shall be approximately 38 mm high by 63 mm projection and shall extend 50 mm on either side of the door opening width.

### 2.13.4 Aluminum Housed Type Weatherseals

Weatherseals of the type indicated shall consist of extruded aluminum retainers not less than 1.78 mm wall thickness with vinyl, neoprene, silicone rubber, polyurethane or vinyl brush inserts. Aluminum shall be bronze anodized. Weatherseal material shall be of an industrial/commercial grade. Seals shall remain functional through all weather and temperature conditions. Air leakage rate of weatherstripping shall not exceed 0.775 liters per second per lineal meter of crack when tested in accordance with

ASTM E 283 at standard test conditions.

2.13.5 Gasketing

Gasketing shall be a compression type seal, silicon based, self-adhesive product for use on steel door frames with wood and steel doors for 45 minute C-label. Color shall be black or bronze. Air leakage rate of weatherstripping shall not exceed 0.775 liters per second per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.13.6 Key Control Storage System

Key control storage system shall consist of two cabinets conforming to BHMA A156.5, Type E8341, capacity 125, and shall be properly labeled for key identification. Set up, identification labeling and location of the key control storage shall be as directed at the Predelivery Conference.

2.13.7 Door Stops

Wall stops, floor stops and combination stop and holders shall conform to BHMA A156.16.

2.14 FASTENINGS

Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields shall be used for attaching hardware to concrete or masonry. Fastenings exposed to the weather in the finished work shall be of brass, bronze, or stainless steel. Sex bolts, through bolts, or machine screws and grommet nuts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved tamperproof screws. Screws for the jamb leaf of half-mortise and full-surface hinges attached to structural steel frames shall be one-way or other approved tamperproof type.

2.15 FINISHES

Unless otherwise specified, finishes shall conform to those identified in BHMA A156.18. Where painting of primed surfaces is required, painting is specified in Section 09900 PAINTING, GENERAL.

2.16 HARDWARE FOR FIRE DOORS

Hardware for fire doors shall conform to the requirements of NFPA 80and NFPA 101.

PART 3 EXECUTION

3.1 APPLICATION

Hardware shall be located in accordance with DHI Locations for CSD and DHI Locations for SSD, except that deadlocks shall be mounted 1220 mm above finish floor. When approved, slight variations in locations or dimensions will be permitted. Application shall be in accordance with DHI ANSI/DHI A115.1G or DHI ANSI/DHI A115-W. Door control devices for exterior doors such as closers and holders, shall be attached to doors with thru bolts and nuts or sex bolts. Alternate fastening methods may be approved by the Contracting Officer when manufacturers' documentation is submitted to verify that the fastening devices and door reinforcements are adequate to resist wind induced stresses. Electric hardware items and access control devices shall be installed in accordance with manufacturer's printed installation procedures.

3.1.1 Hardware for Fire Doors and Smoke-Control Door Assemblies

Hardware for fire doors shall be installed in accordance with the requirements of NFPA 80. Exit devices installed on fire doors shall have a visible label bearing the marking "Fire Exit Hardware". Other hardware installed on fire doors, such as locksets, closers, and hinges shall have a visible label or stamp indicating that the hardware items have been approved by an approved testing agency for installation on fire-rated doors. Hardware for smoke-control door assemblies shall be installed in accordance with NFPA 105.

3.1.2 Door-Closing Devices

Door-closing devices shall be installed and adjusted in accordance with the templates and printed instructions supplied by the manufacturer of the devices. Insofar as practicable, doors opening to or from halls and corridors shall have the closer mounted on the room side of the door.

3.1.3 Key Control Storage Systems

Key control storage system shall be installed where directed.

3.1.4 Kick Plates

Kick plates shall be installed on the push side of single-acting doors.

3.1.5 Auxiliary Hardware

Lever extension flush bolts shall be installed at the top and bottom of the inactive leaf of pairs of doors. The bottom bolt shall operate into a dust-proof floor strike or threshold.

3.1.6 Thresholds

Thresholds shall be secured with a minimum of three fasteners per single door width and six fasteners per double door width with a maximum spacing of 300 mm. Exterior thresholds shall be installed in a bed of sealant with expansion anchors and stainless steel screws, except that bronze or anodized bronze thresholds shall be installed with expansion anchors with brass screws. Minimum screw size shall be No. 10 length, dependent on job conditions, with a minimum of 19 mm thread engagement into the floor or anchoring device used. Thresholds shall have ends scribed neately to jambs

3.1.7 Rain Drips

Door sill rain drips shall align with the bottom edge of the door. Overhead rain drips shall align with bottom edge of door frame rabbet. Drips shall be set in sealant and fastened with stainless steel screws.

3.1.8 Weatherseals

Weatherseals shall be located as indicated, snug to door face and fastened in place with color matched metal screws after door and frames have been finish painted. Screw spacing shall be as recommended by manufacturer.

3.1.9 Gasketing

Gasketing shall be installed at the inside edge of the hinge and head and latch sides of door frame. Frames shall be toleranced for a 3 mm clearance between door and frame. Frames shall be treated with tape primer prior to installation.

3.2 OPERATIONAL TESTS

Prior to acceptance of any electrical hardware system, an operational test shall be performed to determine if devices are operating as intended by the specifications. Wiring shall be tested for correct voltage, current carrying capacity, and proper grounding. Stray voltages in lock wiring shall be eliminated to prevent locking devices from releasing in critical situations.

3.3 FIELD QUALITY CONTROL

Architectural Hardware Consultant shall inspect the completed installation and certify that the hardware has been furnished and installed in accordance with the manufacturers' instructions and as specified. The inspection report shall identify any malfunctioning items and recommend adjustment or replacement as appropriate.

3.4 HARDWARE SETS

HW-1 Doors 101A, 201A and 222A

1 set Floor Closer and Pivot; Refer to Section 08450
2 ea. Pulls J402 (offset) x 25 mm diameter x 250 mm center to center x 630
{AM#0001}_1 ea. Cylinder_ as required x 630
1 ea. Wall Stop, L02251 x 64 mm diamter x 630 with lag bolt
1 ea. Sign with 25 mm high text "DOOR SHALL REMAIN UNLOCKED DURING BUSINESS HOURS"
Balance of hardware by door supplier

HW-2 Doors 101AA, 103B, 201AA, 203B and 223A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Closer, C02051 (Holder Arm) x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt

1 set Sound Seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-3 Doors 101BA, 102B, 104B, 104AA, 113B, 201BA, 202B, 204B, 204AA, 213B, 221B, 229A, 301C and 301D

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt

HW-4 Doors 102A, 107A, 108A, 109A, 110A, 112A, 113A, 116A, 116B, 117A, 118A, 119A, 120A, 121A, 122A, 123A, 125A, 125B, 126A, 127A, 129A, 135BA, 136A, {AM#0001}____ 202A, 207A, 208A, 209A, 210A, 212A, 213A, 216A, 216B, 217A, 218A, 219A, 220A, 221A, 225A, 225B, 226A, 227A, 235BA, 236A, {AM#0001}______ 302A, 314AA and 314BA

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630

HW-5 Doors 103A, 203A and 230B

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Closer, C02051 (Holder Arm) x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Sound Seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-6 Doors 104A, 105A, 135AB, 204A, 205A and 235AB

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Closer, C02021 x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630

HW-7 Doors 106A and 206A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Exit Device, Type 4 x Narrow Stile Push Pad, Function 01 - Grade 1 No Exterior Trim x 626
1 ea. Closer, C02021 PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Sound seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-8 Doors 106B and 206B

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630

1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Sound Seals at head and jambs, ROE155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-9 Doors 106C and 206C

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Cipher Lockset, Kaba Ilco 8100 Series x 626 with key override, or approved equal
1 ea. Closer, C02021 x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Sound Seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-10 Doors 106D and 206D

1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630 Install with keyway on Briefing Room side of door.
1 ea. Dead Bolt Lock, E06071 x blank cylinder with filler/cover x 626 Install thumb turn on Briefing Room side of door.
1 ea. Kick Plate, J102 x 630
1 set Sound Seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-11 Doo{AM#0001}rs 111A, 128A, 130A, 131A, 138A, 211A{AM#0001} and 238A {AM#0001}

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630

HW-12 Pairs of Doors 111B and 211B

2 sets Offset Pivots, C07172 x 19 mm Offset x 613
2 ea. Offset Intermeidate Pivots, C07321 x 19 mm Offset x 613
2 ea. Exit Devices, Type 4 x Narrow Stile Push Pad, Function 04 - Grade 1 x No Exterior Pull x 626
2 ea. Pulls, J402 (offset) x 25 mm diameter x 250 mm center to center x 630
2 ea. Dust Proof Strikes, L04011 x 630
2 ea. Closers, C02021 x PT-4C x Spring-Cushioned Stop Arm x 690
2 ea. Kick Plate, J102 x 630
1 ea. Threshold, J32130 x 127 mm wide x 6 mm high x 628

HW-13 Doors 114A and 214A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Closer, C02021 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt

1 ea. Kick Plate, J102 x 630

HW-14 Doors 115A and 215A

1 pr. Hinges, A5111 x NRP x 630
1/2 pr. Hinges, A5111 with electric through wire (4 wires) x NRP x 630
1 ea. Exit Lock, E0431 x Dead Bolt x Mortise Strike x No Exterior Trim x 9 VDC x 626
1 ea. Power Supply for Exit Lock, 120 VAC x 9 VDC; mount above suspended ceiling.
1 ea. Closers, C02021 x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Sound Seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-15 Door 115AA and 215AA

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plates, J102 x 630
1 set Sound Seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-16 Fire Rated Doors 124A, 224A, 305A and 306A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F07 - Grade 1 x 630
1 ea. Closer, C02011 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-17 Pairs of Doors 133A and 233A

3 pr. Hinges, A5111 x 630
2 ea. Push Plate, J304 x 102 mm x 406 mm x 630
2 ea. Pull Plate, J407 x 102 mm x 406 mm x 630
2 ea. Dust Proof Strike, L04021 x 630
2 ea. Closers, C02061 (Holder Arm) x PT-4F x Low Opening Resistance x 689
2 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
2 ea. Kick Plates, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze
2 ea. Split Astragals, R3E734 x 628

HW-18 Doors 134A and 234A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Push Plate, J304 x 102 mm x 406 mm x 630
1 ea. Pull Plate, J407 x 102 mm x 406 mm x 630
1 ea. Closers, C02061 (Holder Arm) x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt

1 ea. Kick Plate, J102 x 630

HW-19 Doors 135A and 235A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Cipher Lockset, Kaba Ilco 8100 Series x 626 with key override, or approved equal
1 ea. Closer, C02011 x PT-4F x Low Opening Resistance x 689
1 ea. Overhead Concealed Slide Stop, C01541 x 626
1 ea. Kick Plate, J102 x 630

HW-20 Fire Rated Doors 135AA, {AM#0001}_______ 235AA, {AM#0001}____ and 248AB

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Closer, C02011 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-21 Overhead Coiling Doors 135AC and 235AC

1 ea. Cylinder, E09211 x 630
Balance of hardware by door supplier.

HW-22 Doors 137A, 137B, 237A and 237B

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Closer, C02011 x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630

HW-23 Fire Rated Doors 139A, 141BA, 239A and 241BA

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F07 - Grade 1 x 630
1 ea. Closer, C02011 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-24 Fire Rated Doors 140A and 240A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Cipher Lockset, Kaba Ilco 8100 Series x 626 with key override, or approved equal
1 ea. Closer, C02011 x 689
1 ea. Overhead Concealed Slide Stop, C01541 x 626
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-25 Pairs of Fire Rated Doors 140B, 141B, 240B, and 241B

3 pr. Hinges, A5111 x 630
1 ea. Mortise Cipher Lockset, Kaba Ilco 8100 Series x 626 with key override, or approved equal
1 pr. Automatic Flush Bolts, Type 25 x 630
1 ea. Dust Proof Strike, L04021 x 630
1 ea. Closer, C02011 x 689
1 ea. Coordinator, Type 21 x 600
1 ea. Overhead Concealed Slide Stop, C01541 x 626
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
2 ea. Kick Plates, J102 x 630
1 set Smoke seals at head and jambs, R0E154 x black or bronze
1 ea. Astragal, R3E615 x 710

HW-26 Fire Rated Doors 141A, 147D{AM#0001}, 241A {AM#0001}and 314A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Cipher Lockset, Kaba Ilco 8100 Series x 626 with key override, or approved equal
1 ea. Closer, C02011 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630
1 set Smoke seals at head and jambs, R0E154 x black or bronze

HW-27 Overhead Doors 141C, 142B, 147B, 148B, 241C, 242B, 247B and 248B

1 ea. Padlock
Balance of hardware by door supplier.

HW-28 Doors 141AA{AM#0001}, 241AA {AM#0001}and 248AA

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630

HW-29 Pairs of Fire Rated Doors 142A and 242A

3 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 pr. Automatic Flush Bolts, Type 25 x 630
1 ea. Dust Proof Strike, L04021 x 630
2 ea. Closers, C02011 x 689
2 ea. Overhead Concealed Slide Stops, C01541 x 626
1 ea. Coordinator, Type 21 x 600
2 ea. Kick Plates, J102 x 630
1 set Smoke seals at head and jambs, R0E154 x black or bronze
1 ea. Astragal, R3E614 x 710

HW-30 Pairs of Doors 143A, {AM#0001}__243A, and 245A

3 pr. Hinges, A5111 x NRP x 630
1 ea. Mortise Lockset, F07 - Grade 1 x 630
1 pr. Lever Extension Flush Bolts, L54081 x 630
1 ea. Dust Proof Strike, L04011 x 630
2 ea. Closers, C02021 x Spring-Cushioned Stop Arm x 689
1 set Weather Seals at head and jambs
1 ea. Astragal, R3E615 x 710
1 ea. Offset Threshold with Applied Stop, J32182 x 140 mm wide x 25 mm high total x 13 mm offset x 628
2 ea. Door Sill Rain Drips x 710
1 ea. Overhead Rain Drip x 710

HW-31 Doors 144A and 244A

1 1/2 pr. Hinges, A5111 x NRP x 630
1 ea. Mortise Lockset, F07 - Grade 1 x 630
1 ea. Closer, C02021 x Spring-Cushioned Stop Arm x 689
1 set Weather Seals at head and jambs
1 ea. Offset Threshold with Applied Stop, J32182 x 140 mm wide x 25 mm high total x 13 mm offset x 628
2 ea. Door Sill Rain Drips x 710
1 ea. Overhead Rain Drip x 710

HW-32 Fire Rate Doors 146B and 246A

1 1/2 pr. Hinges, A5111 x NRP x 630
1 ea. Mortise Lockset, F07 - Grade 1 x 630
1 ea. Closer, C02021 x PT-4G x 689
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-33 Pairs of Doors 147A and 247A

3 pr. Hinges, A5111 x NRP x 630
1 ea. Mortise Lockset, F07 - Grade 1 x 630
1 pr. Automatic Flush Bolts, Type 25 x 630
1 ea. Dust Proof Strike, L04011 x 630
2 ea. Closers, C02061 x Spring-Cushioned Stop/Holder Arm x 689
1 ea. Coordinator, Type 21 x 600
2 ea. Kick Plates, J102 x 630
1 set Weather Seals at head and jambs
1 ea. Offset Threshold with Applied Stop, J32182 x 140 mm wide x 25 mm high total x 13 mm offset x 628
1 ea. Astragal, R3E615 x 710
2 ea. Door Sill Rain Drips x 710
1 ea. Overhead Rain Drip x 710

HW-34 Fire Rated Overhead Coiling Doors 147C and 247C

1 ea. Padlock
Balance of hardware by door supplier.

HW-35 Fire Rated Doors 148A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Cipher Lockset, Kaba Ilco 8100 Series x 626 with key override, or approved equal
1 ea. Closer, C02021 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630
1 set Smoke seals at head and jambs, R0E154 x black or bronze

HW-36 Fire Rated Overhead Coiling Doors 148C and 248C

1 ea. Padlock
Balance of hardware by door supplier.

HW-37 Pairs of Doors 148FA, 248DA, 325A and 329A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Push Plate, J304 x 102 mm x 406 mm x 630
1 ea. Pull Plate, J407 x 102 mm x 406 mm x 630
2 ea. Door Operators, Horton Series 4000 Heavy Duty Swing Door Operators, 120 VAC x 710, or approved equal
2 ea. Motion Sensors, Microwave unidirectional/bidirectional sensors to activate doors upon approach from either side, 24 VAC.
1 ea. Swing Side Safety Sensor, Sensor utilizing a combination of focused and diffused technology to prevent closed doors from opening or open doors from closing when safety zone is occupied, 24 VAC.
1 ea. Safety Beam System, Beam type sensor system mounted on end of guide rails at swing side of doors, to stop doors if beam is interrupted during opening cycle and to ensure the area is clear before resuming normal operation, 24 VAC.
2 ea. "Automatic Door" decals for installation on doors
2 sets Non-swing and swing side decals for installation on doors, 152 mm diameter
2 ea. Wall Stops, L52251 x 64 mm diameter x 630 with lag bolt
2 ea. Armor Plates, J101 x 630
2 ea. Door Edge Guards, J203M x 900 mm tall x 630
1 set Air Seals at head and jambs, R0E155 x black or bronze
2 ea. Split Astragals, R3E734 x 628

HW-38 Pairs of Doors 148FB, 248DB, 325B and 329B

2 pr. Hinges, A5111 x NRP x 630
1 pr. Hinges, A5111 with electric through-wire (4 wires) x NRP x 613
2 ea. Pull, J402 (offset) x 25 mm diameter x 630
2 ea. Door Operators, Horton Series 4000 Heavy Duty Swing Door Operators, 120 VAC x 710, or approved equal
2 ea. Motion Sensors, Microwave unidirectional/bidirectional sensors to activate doors upon approach from either side, 24 VAC.
1 ea. Swing Side Safety Sensor, Sensor utilizing a combination of focused and diffused technology to prevent closed doors from opening or open doors from closing when safety zone is occupied,

24 VAC.
1 ea. Safety Beam System, Beam type sensor system mounted on end of guide rails at swing side of doors, to stop doors if beam is interrupted during opening cycle and to ensure the area is clear before resuming normal operation, 24 VAC.
2 ea. "Automatic Door" decals for installation on doors
2 sets Non-swing and swing side decals for installation on doors, 152 mm diameter
2 ea. Electromagnetic Lock, E08501 x BHMA Certified 6673 N (1500 lb.) Strength, Security Door Controls 1511 x 24 VDC x 313, or approved equal; Mount on secured side of door at door head.
1 ea. Power Supply, Security Door Controls 631RF, 1 Amp, 120 VAC x 24 VDC with battery back-up and batteries, or approved equal
2 ea. Pressure Sense Bars, Security Door Controls MSB550V, 24 VDC x 628, or approved equal; allow egress from building interior when doors are in secured mode.
1 ea. Wall Switch, (specified in Division 16), Provide two modes of operation. Secured Mode: Activate electromagnetic lock, pressure sense bars and digital keypad and deactivate door operators. Unsecured Mode: Activate door operators and deactivate electromagnetic locks, pressure sense bars and digital keypad.
1 ea. Digital Keypad, (specified in Division 16), allow access from building exterior when doors are in secured mode.
1 ea. Key Switch, (specified in Division 16), allow access from building exterior when doors are in secured mode.
2 ea. Wall Stops, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
2 ea. Armor Plates, J101 x 630
2 ea. Door Edge Guards, J203M x 900 mm tall x 630
1 ea. Threshold J32130 x 152 mm wide x 6 mm high x 628
2 ea. Door Shoe with Drip Cap, R3E535 x 710
1 set Weather Seals at head and jambs
2 ea. Split Astragals, R3E735 x 628

HW-39 Door 228A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Closer, C02051 (Holder Arm) x PT-4F x Low Opening Resistance x 689
1 ea. Kick Plate, J102 x 630

HW-40 Door 230A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Closer, C02051 (Holder Arm) x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Sound Seals at head and jambs, R0E155 x black or bronze
1 ea. Automatic Door Bottom, R3Y335 x 628

HW-41 Fire Rated Door 248A

1 1/2 pr. Hinges, A5111 x 630

1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Closer, C02021 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-42 Fire Rated Door {AM#0001} 248CA

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Closer, {AM#0001} C02011 x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-43 Door 249A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630

HW-44 Pairs of Doors 301A and 301B

3 pr. Hinges, A5111 x 630
2 ea. Exit Devices, Type 5 x Narrow Stile Push Pad, Function 08 - Grade 1 x Lever Handle x 626
2 ea. Dust Proof Strikes, L04011 x 630
1 ea. Closer, C02021 x PT-4F x Low Openign Resistance x 689
1 ea. Closer, C02021 x PT-G x PT-4F x Low Opening Resistance x 689
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
2 ea. Kick Plates, J102 x 630
2 ea. Adjustable Astragals, R3E835 x Sound Rated x 628
1 set Sound Seals at head and jambs, R0E155 x black x bronze
2 ea. Automatic Door Bottoms, R3Y335 x 628

HW-45 Doors 303A and 304A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Push Plate, J304 x 102 mm x 406 mm x 630
1 ea. Pull Plate, J407 x 102 mm x 406 mm x 630
1 ea. Closers, C02021 x PT-4F x Low Opening Resistance x 689
1 ea. Kick Plate, J102 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt

HW-46 Doors 307A, 308A and 309A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Overhead Concealed Slide Stop, C01541 x 626
1 ea. Kick Plate, J102 x 630

HW-47 {AM#0001}Fire Rated Doors 310A and 311A

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F07 - Grade 1 x 630
1 ea. Closer, C02021 {AM#0001} x 689
{AM#0001}1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
{AM#0001}1 ea. Kick Plate, J102 x 630
{AM#0001}1 ea. Smoke Seals at head and jambs, R0E154 x black or bronze

HW-48 Fire Rated Door {AM#0001} 248BA

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Cipher Lockset, Kaba Ilco 8100 Series x 626 with key override, or approved equal
1 ea. Closer, C02011 x 689
1 ea. {AM#0001} Wall Stop, L52{AM#0001} 251 x 64 mm dimater x 630 {AM#0001}with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630
1 set Smoke seals at head and jambs, R0E154 x black or bronze

HW-49 Fire Rated Door 314C

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F05 - Grade 1 x 630
1 ea. Closer, C02011 x 689
1 ea. Floor Stop, L52141 x 630
1 ea. Kick Plate, J102 x 630
1 set Smoke Seals at head and jambs, R0E154 x black or bronze

HW-50 Fire Rated Door 314CA

1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Closers, C02011 x 689
1 ea. Overhead Concealed Slide Stop, C01541 x 626
2 ea. Kick Plates, J102 x 630
1 set Smoke seals at head and jambs, R0E154 x black or bronze

HW-51 Pair of Doors 315A

2 sets Offset Pivots, C07172 x 19 mm Offset x 613
2 ea. Offset Intermediate Pivots, C07321 x 19 mm Offset x 613
1 ea. Exit Devices, Type 6, x Narrow Stile Push Pad, Function 08 - Grade 1 x Lever Handle x 626
1 ea. Exit Devices, Type 6, x Narrow Stile Push Pad, Function 13 - Grade 1 x No Exterior Pull x 626
1 ea. Mortise Cipher Lockset, Kaba Ilco LP1000 Series x 626 with key override and passage function, or approved equal
2 ea. Dust Proof Strikes, L04011 x 630
2 ea. Pulls, J402 (offset) x 25 mm diameter x 250 mm center to center x 630
1 ea. Closer, C02021 x 690
1 ea. Low Energy Power Operator, 120 VAC x 710
2 ea. Push Plate Wall Switches with Uniform Accessibility Symbol

1 ea. "Caution" signage for installation on door
1 ea. Stike Switch, 120 VAC or 24 VDC as required to disengage power operator push plate wall switches when exit device head bolt is extended (locked door condition)
1 ea. Threshold, J32130 x 127 mm wide x 6 mm high x 628

HW-52 Pair of Doors 315B

2 sets Offset Pivots, C07172 x 19 mm Offset x 613
2 ea. Offset Intermediate Pivots, C07321 x 19 mm Offset x 613
2 ea. Push Bars, J501 x 25 mm diameter x 630
2 ea. Pulls, J402 (offset) x 25 mm diameter x 250 mm center to center x 630
1 ea. Closer, C02011 x PT-4F x Low Opening Resistance x 690
1 ea. Low Energy Power Operator, 120 VAC x 710; mount in vestibule
1 ea. Push Plate Wall Switch with Uniform Accessibility Symbol
1 ea. "Caution" signage for installation on door

HW-53 Doors 320A, 322A, 330A and 332A

1 set Offset Pivots, C07172 x 19 mm Offset x 613
1 ea. Offset Intermediate Pivots, C07321 x 19 mm Offset x 613
1 ea. Push Bar, J501 x 25 mm diameter x 630
1 ea. Pull, J402 (offset) x 25 mm diameter x 250 mm center to center x 630
1 ea. Closer, C02021 x PT-4F x Low Opening Resistance x 690
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield

HW-54 Doors 320B, 322B, 330B and {AM#0001} 332B

1 set Offset Pivots, C07172 x 19 mm Offset x 613
1 ea. Offset Intermediate Pivots, C07321 x 19 mm Offset x 613
1 ea. Exit Device, Type 4, x Narrow Stile Push Pad, Function 13 - Grade 1 x No Exterior Pull x 626
1 ea. Mortise Cipher Lockset, Kaba Ilco LP1000 Series x 626 with key override and passage function, or approved equal
1 ea. Closers, C02021 x 690
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Threshold, J32130 x 127 mm wide x 6 mm high x 628

HW-55 Pairs of Fire Rated Doors 401A

3 pr. Hinges, A5111 x 630
1 ea. Cylindrical Latchset, F75 - Grade 1 x Lever Handle at room exterior x Blank Trim at room interior x 630
1 ea. Dead Lock, E06061 x 626
1 pr. Lever Extension Flush Bolts, L54081 x 630
1 ea. Dust Proof Strike, L04021 x 630
{AM#0001}
1 set Smoke Seals at head and jambs, R0E154 x black or bronze
1 ea. Astragal, R3E614 x 710
{AM#0001}2 ea. Wall Stops, L52251 x 64 mm diameter x 630 with lag bolt

1 ea. Threshold with Applied Stop, J32123 x 152 mm wide x 12 mm high x 628

HW-56 Sectional Overhead Doors 146A and 246A

1 ea. Cylinder, E09211 x 630
Balance of hardware by door supplier.

HW-57 Security Fence Gates (Refer to Civil Drawings)

1 ea. Padlock, keyed to Grand Master Key "A" and keyed individually as directed

{AM#0001}HW-58 Doors 142AA, 147AA, 148AA, 148BA, 148CA, 148DA, 148EA, 242AA, 247AA and 248AA

{AM#0001}1 1/2 pr. Hinges, A5111 x 630
1 ea. Mortise Lockset, F04 - Grade 1 x 630
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt and expansion shield
1 ea. Kick Plate, J102 x 630

{AM#0001}HW-59 Pairs of Doors 140C and 240C

{AM#0001}2 pr. Double Acting Spring Hinges, K81091 x 626
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
4 ea. Armor Plates, J101 1050 mm tall x 630
2 ea. Door Edge Guards, J209M x 1050 mm tall x 630

{AM#0001}HW-60 Door 314BB

{AM#0001}1 ea. Single Acting Spring Hinge, K81071 x 652
1 ea. Hinge, A8111 x 652
1 ea. Wall Stop, L52251 x 64 mm diameter x 630 with lag bolt
1 pc. Sound Seal at strike jamb, R0E155 x black or bronze
1 ea. Continuous Gear Hinge for flip-up counter, Hagar Roton 750-134 x 628 or approved equal

{AM#0001}HW-61 Pair of Doors 145A

{AM#0001}3 pr. Hinges, A5111 x NRP x 630
2 ea. Exit Devices, Type 5 x Narrow Stile Push Pad, Function 08 - Grade 1 x Lever Handle x 626
2 ea. Dust Proof Strikes, L04011 x 630
2 ea. Closers, C02021 x Spring-Cushioned Stop Arm x 689
1 set Weather Seals at head and jambs
2 ea. Split Astragals, R3E735 x 628
1 ea. Offset Threshold with Applied Stop, J32182 x 140 mm wide x 25 mm high total x 13 mm offset x 628
2 ea. Door Sill Rain Drips x 710
1 ea. Overhead Rain Drip x 710

-- End of Section --

# SECTION 09510

# ACOUSTICAL CEILINGS
**10/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 635 | (2000) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings |
| ASTM C 636 | (1996) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels |
| ASTM E 580 | (2000) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint |
| ASTM E 1264 | (1998) Standard Classification for Acoustical Ceiling Products |
| ASTM E 1414 | (2000) Standard Test for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| TI 809-04 | (1998) Seismic Design for Buildings |

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, ED.

Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.

SD-03 Product Data

Acoustical Ceiling Systems.

Manufacturer's descriptive data, catalog cuts, and installation instructions. Submittals which do not provide adequate data for the product evaluation will be rejected.

SD-04 Samples

Acoustical Units; G, ED.

Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color.

SD-07 Certificates

Acoustical Units.

Certificate attesting that the mineral based acoustical units furnished for the project contain recycled material and showing an estimated percent of such material.

## 1.3 GENERAL REQUIREMENTS

Acoustical treatment shall consist of sound controlling units mechanically mounted on a ceiling suspension system. The unit size, texture, finish, and color shall be as specified. The Contractor has the option to substitute inch-pound (I-P) Recessed Light Fixtures (RLF) for metric RLF. If the Contractor opts to furnish I-P RLF, other ceiling elements like acoustical ceiling tiles, air diffusers, air registers and grills, shall also be I-P products. The Contractor shall coordinate the whole ceiling system with other details, like the location of access panels and ceiling penetrations, etc., shown on the drawings. If I-P products are used, the Contractor shall be responsible for all associated labor and materials and for the final assembly and performance of the specified work and products. The location and extent of acoustical treatment shall be as shown on the approved detail drawings.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Materials shall be carefully handled and stored in dry, watertight enclosures. Immediately before installation, acoustical units shall be stored for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

## 1.5 ENVIRONMENTAL REQUIREMENTS

A uniform temperature of not less than 16 degrees C nor more than 29 degrees C and a relative humidity of not more than 70 percent shall be maintained before, during, and after installation of acoustical units.

## 1.6 SCHEDULING

Interior finish work such as plastering, concrete and terrazzo work shall be complete and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

## 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided. Standard performance guarantee or warranty shall contain an agreement to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

## 1.8 EXTRA MATERIALS

Spare tiles of each color shall be furnished at the rate of 5 tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

# PART 2 PRODUCTS

## 2.1 ACOUSTICAL UNITS

Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

### 2.1.1 Units for Exposed-Grid System ATC-1

Type: III (mineral fiber with painted finish). Type III acoustical units shall have a minimum recycled material content of 18 percent.

Minimum NRC: 0.65 when tested on mounting No. E-400

Pattern: J

Nominal size: 610 by 610 mm.

Edge detail: Tegular.

Finish: Factory-applied standard finish.

Minimum LR coefficient: 0.70.

Minimum CAC: 35.

2.1.2 Units for Open Cell System ATC-2

2.1.2.1 Lay-In Cell Panel

The panel shall measure 610 mm x 610 mm and be comprised of U-shaped metal blades, measuring 51 mm high and 14 mm wide, that form cell shapes of sizes 305 mm x 305 mm. Painted panels shall be manufactured from .010 steel or .020 aluminum with {AM#0001} an aluminum finish.

2.1.2.2 Suspension System Components

The suspension system components for the Cell panel shall be a 14 mm grid system. The components shall interlock to 610 mm x 610 mm modules in which the Cell panel will lay. The suspension system shall be comprised of two components: main runner and cross tee.

2.1.2.3 Accessory Item

Web covers, designed to conceal the webs of the main runner and cross tee components, shall be formed to a U-shape, measuring 51 mm high x 8 mm wide. The components shall measure either 610 mm or 1220 mm in length, depending on the application, and shall be formed from .010 steel or .012 aluminum. Web covers shall be made available with slotting to facilitate installation at hanger wire points as installation conditions dictate.

2.1.2.4 Perimeter Treatment

Two types of perimeter treatment, an angle and an edge cap, shall be offered for the Cell ceiling system.

a. The angle shall be manufactured to an "L" shape, 3048 mm in length, 51 mm high and 25 mm wide. The angle shall be formed from the same type of metal as the other Cell components, and shall be painted on both its inner and outer side. The angle component is to be utilized whenever the Cell system is to be attached to a wall.
b. The edge cap shall be manufactured to a "C" shape, 3048 mm in length, with the legs of the component measuring 9 mm and 14 mm in width and the web of the component measuring 52 mm (I.D.). The edge cap shall be formed from the same metal as the other Cell components, and shall be painted on both its inner and outer side. The edge cap is to be utilized for all free-floating Cell installations.

2.1.3 Units For Metal Panel Ceiling System (ATC-3)

2.1.3.1 Panel

a. Profile: Flat sheets sized to lay-in specified grid module.
b. Material/Thickness: Aluminum/minimum 0.8 mm.
c. Grid Module Width/Length: 610 mm by 610 mm.
d. Ceiling System Radius/Orientation: 3990 mm/Vault.

2.1.3.2 Suspension System

Heavy Duty classification in accordance with ASTM C 635.

a. Exposed curved Grid Type: Metal flat sheets sized and designed to lay-in and form to radius of exposed curved grid system. Metal sheets to be held down in place with hold down clips (minimum four clips per panel) using grid clips designed to positively lock down on top bulb of curved grid, holding panel face flush to curved grid.
b. Main Runners: 38 mm deep, inverted "Tee" section 1829 mm or 3048 mm long, curved in factory to specified radius and orientation.
c. Cross Runners: Nominal 610 mm long, 38 mm deep, inverted "Tee: sections designed to interlock in to web of main tee section on specified module spacing, for a maximum spacing of 1829 mm.
d. Hanger Wire: 12 Ga. pre-stretched galvanized steel.
e. Coatings and Finishes: In compliance with ASTM C 635

2.1.4 Units for Exposed-Grid System ATC-4

Type: XX (high density ceramic-like composition with scrubbable finish).

Minimum NRC: 0.55 when tested on mounting No. E-400

Pattern: C D.

Nominal size: 610 by 610 mm.

Edge detail: Trimmed and butt.

Finish: Scrubbable Factory-applied vinyl plastic Paint.

Minimum LR coefficient: 0.84.

Minimum CAC: 38.

2.2 SUSPENSION SYSTEM

Suspension system shall be standard exposed-grid standard width flange, and shall conform to ASTM C 635 for intermediate-duty systems. Surfaces exposed to view shall be aluminum or steel with a factory-applied white baked-enamel finish. Wall molding shall have a flange of not less than 23 mm. nside and outside corner caps shall be provided. Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of 1/360 of span length. Seismic details shall conform to the guidance in TI 809-04 and ASTM E 580.

2.3 HANGERS

Hangers shall be galvanized steel wire. Hangers and attachment shall support a minimum 1330 N ultimate vertical load without failure of supporting material or attachment.

2.4 HEAVY-DUTY SUSPENSION SYSTEM AND HANGERS

Where indicated on the drawings, provided heavy-duty suspension and hangers to support acoustical ceiling panels and additional applied materials (16 mm gypsum board and and 50 mm duct liner) for acoustical control. Lighting fixtures these areas shall also be "tented" with 16 mm gypsum board panels and 50 mm duct liner.

## 2.5 FINISHES

Acoustical units and suspension system members shall have manufacturer's standard textures, patterns and finishes as specified. Ceiling suspension system components shall be treated to inhibit corrosion.

## 2.6 COLORS AND PATTERNS

Colors and patterns for acoustical units and suspension system components shall be as shown on the Contract Drawings.

## 2.7 CEILING ATTENUATION CLASS AND TEST

Ceiling attenuation class (CAC) range of acoustical units, when required, shall be determined in accordance with ASTM E 1414. Test ceiling shall be continuous at the partition and shall be assembled in the suspension system in the same manner that the ceiling will be installed on the project. System shall be tested with all acoustical units installed.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Acoustical work shall be provided complete with necessary fastenings, clips, and other accessories required for a complete installation. Mechanical fastenings shall not be exposed in the finished work. Hangers shall be laid out for each individual room or space. Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Main runners and carrying channels shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span. Wherever required to bypass an object with the hanger wires, a subsuspension system shall be installed, so that all hanger wires will be plumb.

### 3.1.1 Suspension System

Suspension system shall be installed in accordance with ASTM C 636 and as specified herein. There shall be no hanger wires or other loads suspended from underside of steel decking.

#### 3.1.1.1 Plumb Hangers

Hangers shall be plumb and shall not press against insulation covering ducts and pipes.

#### 3.1.1.2 Splayed Hangers

Where hangers must be splayed (sloped or slanted) around obstructions, the resulting horizontal force shall be offset by bracing, countersplaying, or other acceptable means.

3.1.2 Additional Acoustical Control

Where indicated on the drawings and after acoustical ceilings and heavy-duty suspension system and hangers have been installed, provided additional acoustical control as follows:

3.1.2.1 Gypsum Board

Loose lay 16 mm gypsum board panels on top of T-bar suspension system; to maintain warranty of acoustical ceiling panels, do not allow gypsum board panels to come into contact with acoustical ceiling panels. Cut gypsum board panels to largest practical size. Butt joints as tight as possible to form a continuous acoustical barrier.

3.1.2.2 Duct Liner

Loose lay 50 mm duct liner with scrim face on top of 16 mm gypsum board panels. Butt joints as tight as possible to form a continuous acoustical barrier.

3.1.2.3 Tented Lighting Fixtures

Tent all lighting fixtures with 16 mm gypsum board and top with 50 mm duct liner.

3.1.3 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Wall molding shall be secured not more than 75 mm from ends of each length and not more than 400 mm on centers between end fastenings. Wall molding springs shall be provided at each acoustical unit in semi-exposed or concealed systems.

3.1.4 Acoustical Units

Acoustical units shall be installed in accordance with the approved installation instructions of the manufacturer. Edges of acoustical units shall be in close contact with metal supports, with each other, and in true alignment. Acoustical units shall be arranged so that units less than one-half width are minimized. Units in exposed-grid system shall be held in place with manufacturer's standard hold-down clips, if units weigh less than 5 kg per square m or if required for fire resistance rating.

3.2 INSTALLATION OF OPEN CELL SYSTEM ATC-2

3.2.1 Suspension Components

Main runners shall be installed 1220 mm o.c., and be suspended directly from the structure above by not less than 12 gauge electro-galvanized steel hanger wire spaced 1220 mm o.c. along the length of the main runner. The hanger wire shall be inserted into factory-punched holes, located along the length of the main runner, and secured accordingly. The main runners are to be interconnected by cross runner components that are installed 610 mm o.c. along the length of the main runner.

3.2.2 Web Covers

In order to provide the suspension components with an appearance is consistent with the cell panels, web covers shall be utilized as appropriate to conceal the exposed vertical webs of suspension components. When necessary, hanger wire shall be threaded through both main runner and slotted web covers prior to system leveling and wire tying. Elsewhere, install web covers over the exposed webs of grid components prior to cell panel installation.

3.2.3 Lay-In Cell Panel

The 610 mm x 610 mm cell panel shall lay into the same-size module created by the suspension components and be supported by the flanges of these components.

3.2.4 Perimeter Treatment

Angle shall be utilized in those instances where the Cell system is to be attached directly to a wall or other structure that establishes the perimeter of the installation. The angle may be attached utilizing an industry-accepted practice, with care taken to minimize the placement of attachment devices in those visible areas between the blades of the panel. In those instances where the Magna T-Cell System is to have floating perimeter, the edge cap shall be utilized. The cap shall be affixed to the exposed edges of the Cell system by means of screw attachment.

3.2.5 Installation of Metal Panel Ceiling System ATC-3

3.2.5.1 Curved Exposed Grid

Install curved exposed grid metal ceiling system in accordance with manufacturer's printed installation instructions, submittals, applicable industry standards, and governing regulatory requirements for the work.

3.2.5.2 Suspension System Installation

Install in accordance with ASTM C 636.

a. Main Runners: Install curved main runners at a spacing of 610 mm. Suspend main runners using hanger wires spaced at maximum 1219 mm on-centers and within 305 mm of walls. Splice ends of each curved main runner with manufacturers standard splice component.
b. Assemble curved tee grid suspension system by connecting 610 mm cross runners to suspended curved main runners to form a mounting grid for the ceiling panel. Cross runner spacing to match specified panel module length of 610 mm.

3.2.5.3 Panel Installation

a. Install metal ceiling panels by laying flat metal panels into grid module.

b. Install panel hold down clips by pushing clips down onto top bulb of curved main runners such that slips seat metal panel to inside face of grid and lock firmly onto top bulb of grid. Clips will hold metal panel in final position, flush with curved main runner. Hold down clips shall be placed on curved main runners within 2 inches of each corner, and at center point of panels where required.

## 3.3 CLEANING

Following installation, dirty or discolored surfaces of acoustical units shall be cleaned and left free from defects. Units that are damaged or improperly installed shall be removed and new units provided as directed.

-- End of Section --

# SECTION 10442

## INTERIOR AND EXTERIOR SIGNAGE
**09/2000**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

| | |
|---|---|
| AA DAF-45 | (1980) Designation System for Aluminum Finishes |
| AA SAA-46 | (1978) Standards for Anodized Architectural Aluminum |
| AA PK-1 | (1989) Registration Record of Aluminum Association Alloy Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z97.1 | (1984; R 1994) Safety Glazing Materials Used in Buildings. |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM B 209 | (2002) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B 221 | (1992a) Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes |

FEDERAL SPECIFICATIONS (FS)

| | |
|---|---|
| FS L-P-387 | (Rev. A; Am. 1; Int. Am. 2) Plastic Sheet, Laminated, Thermosetting (for Designation Plates). |

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications.

Prior to start of sign installation, submit resumes of work experience for all installers. The work shall be done by qualified, experienced installers, working under a qualified supervisor. The supervisor shall have a minimum of 5 years experience in this area of work and shall be certified by the sign manufacturer.

Sign Schedule; G, ED.

Prior to sign fabrication, submit sign schedule indicating type, size, location, and message of signs to be furnished and installed.

Installation Procedures.

Before installation, submit the sign manufacturer's printed instructions for installation of the signs. Include complete procedures, including preparation of wall or door surfaces, mounting techniques, and recommended adhesives, tapes, or fasteners.

SD-02 Shop Drawings

Interior Signage; G, ED.

Drawings shall clearly show elevations of each sign type, dimensions, materials, typographic layouts, sizes, methods, finishes, anchorages, and other details of construction as well as relation to supporting and adjacent work where applicable. Drawings shall include typical layouts of each sign type showing graphic quality, letterforms, symbols, and type spacing, and a schedule showing the location of each sign type.

SD-03 Product Data

Interior Signage.

Submit manufacturer's catalog data, describing the sign type, materials, and fabrication for each sign type furnished for this project.

SD-04 Samples

Interior Signage; G, ED.

Submit one full size sample of each sign type in the quality and color specified. The samples may be installed in the work provided each sample is identified and location recorded.

SD-10 Operation and Maintenance Data

Sign Maintenance Instructions.

Submit three copies of the sign manufacturer's maintenance instructions, including one quart of any special cleaning solution recommended and furnished by the manufacturer. Cleaning solution(s) shall be properly marked. Instructions shall include the recommended type of cleaning equipment and materials, cleaning methods, and cleaning cycles.

## 1.3 DELIVERY AND STORAGE

Deliver signs to the site in manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size and related information. Each sign shall be individually packaged. Store in a safe, dry, clean, and well ventilated area, protected from damage, soiling, and moisture. Store packages flat. Do not open containers until needed for installation unless verification inspection is required. Protective paper shall be removed only as necessary during fabrication, inspection, or installation in order to avoid scratching, chipping, or crazing the acrylic sheets.

### 1.3.1 Character Proportions and Heights

Letters and numbers on indicated signs in this handicapped-accessible building, which do not designate permanent rooms or spaces, shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted.

### 1.3.2 Raised and Brailled Characters and Pictorial Symbol Signs (Pictograms)

Letters and numbers on indicated signs which designate permanent rooms and spaces in this handicapped-accessible building shall be raised 0.8 mm upper case, sans serif or simple serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 16 mm in height, but no higher than 50 mm. Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 152 mm minimum in height. This facilityshall use the international symbol of accessibility.

## 1.4 EXTRA STOCK

The Contractor shall provide 6 extra frames and extra stock of the following: 6 blank plates of each color and size for all sign types .

## 1.5 IN-HOUSE MANAGEMENT SOFTWARE

Two copies of in-house sign management software and one package of paper inserts (50 sheets) shall be provided.

# PART 2 PRODUCTS

## 2.1 GENERAL

Interior signs and graphics shall be provided as a total system. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Signs shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

## 2.2 MATERIALS AND FINISHES

### 2.2.1 Framing and Fasteners

#### 2.2.1.1 Aluminum Alloy Products

Aluminum extrusions shall be at least 3.2 mil thick, and aluminum plate or sheet shall be at least 1.5 mm thick. Extrusions shall conform to ASTM B 221; plate and sheet shall conform to ASTM B 209. Where anodic coatings are specified, alloy shall conform to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes shall be as shown and shall conform to AA SAA-46.

#### 2.2.1.2 Finishes

Aluminum used for concealed framing of sign shall have a mill finish. Aluminum used for exposed surfaces shall have a dark bronze anodized finish. Anodized finish shall be AA DAF-45 designation AA-M10-C22-A32, Architectural Class II (0.01 mm to 0.02 mm) for integral color.

#### 2.2.1.3 Adhesives

Adhesives and adhesive tapes required for plastics, glass, and metals shall be the type recommended by the sign manufacturer.

### 2.2.2 Plastic

Signs shall be fabricated of Type ES melamine plastic conforming to FS L-P-387, Type NDP self-extinguishing or acrylic conforming to ANSI Z97.1. Plastic sheet used for signs shall be of new stock and free from defects which would impair strength, durability, and appearance. Clear face sheets shall be matte finish. Colored, opaque face plates and plaques shall be smooth finish.

## 2.3 ROOM IDENTIFICATION/DIRECTIONAL SIGNAGE SYSTEM

### 2.3.1 Standard Interior Room Signs

Signs shall consist of matte finish laminated thermosetting Type MP plastic. Frames shall be molded acrylic. Corners of signs shall be 13 mm radius.

2.3.2 Type of Mounting For Signs

Surface mounted signs shall be provided with 1.6 mm thick vinyl foam tape or countersunk mounting holes in plaques and mounting screws.

2.3.3 Graphics

Permanent signage graphics for standard room signs shall conform to the following:

Graphics for Sign Types 1, 2 and 3 shall be raised 0.8 mm from the background.

Changeable graphics shall be accomplished by the user, using computer software and paper provided by the the manufacturer. Initial sign message shall be provided by the sign manufacturer as shown on the drawings. Changeable message shall be protected by a clear acrylic faceplate with invisible locking system.

2.4 {AM#0001}DELETED

2.5 {AM#0001}BUILDING DIRECTORY

{AM#0001}Building Directory shall have an extruded aluminum frame with double strength 3 mm clear glazing. It shall consist of a permanent header panel, with a map and directory section that lists each organization and its tenants. The directory section shall be changeable strip inserts, accessible by an aluminum frame swinging door mounted with a full length piano hinge.

2.6 FABRICATION AND MANUFACTURE

2.6.1 Factory Workmanship

Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.6.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.7 COLOR, FINISH, AND CONTRAST

Color shall be as indicated on the drawings. Characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION (NOT USED)

3.1 INSTALLATION

Signs shall be installed in accordance with approved manufacturer's instructions at locations shown on the drawings.  Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified.  Required blocking shall be installed as recommended by the sign manufacturer.  Signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be installed on the wall adjacent to the latch side of the door.  Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall.  Mounting location for such signage shall be so that a person may approach within 75 mm of signage without encountering protruding objects or standing within the swing of a door.  Signs shall not be installed until finishes have been installed.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.  Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish.  Where recommended by signage manufacturer, foam tape pads may be used for anchorage.  Foam tape pads shall be minimum 2 mm thick closed cell vinyl foam with adhesive backing.  Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam.  Adhesive surfaces shall be protected with a 0.13 mm green flatstock treated with silicone.  Foam pads shall be sized for the signage as per signage manufacturer's recommendations.  Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction.  Hardware and electrical equipment shall be adjusted for proper operation.  Glass, frames, and other sign surfaces shall be cleaned in accordance with the manufacturer's approved instructions.

-- End of Section --

# SECTION 13280

# ASBESTOS ABATEMENT
**11/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z87.1 | (1989; Errata; Z87.1a) Occupational and Educational Eye and Face Protection |
| ANSI Z88.2 | (1992) Respiratory Protection |
| ANSI Z9.2 | (1979; R 1991) Fundamentals Governing the Design and Operation of Local Exhaust Systems |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM C 732 | (1995) Aging Effects of Artificial Weathering on Latex Sealants |
| ASTM D 1331 | (1989; R 1995) Surface and Interfacial Tension of Solutions of Surface-Active Agents |
| ASTM D 2794 | (1993; R 1999el) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) |
| ASTM D 4397 | (1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications |
| ASTM D 522 | (1993a) Mandrel Bend Test of Attached Organic Coatings |
| ASTM E 119 | (2000) Fire Tests of Building Construction and Materials |
| ASTM E 1368 | (2000) Visual Inspection of Asbestos Abatement Projects |

| | |
|---|---|
| ASTM E 736 | (1992) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members |
| ASTM E 84 | (2000a) Surface Burning Characteristics of Building Materials |
| ASTM E 96 | (2000) Water Vapor Transmission of Materials |

COMPRESSED GAS ASSOCIATION (CGA)

| | |
|---|---|
| CGA G-7 | (1990) Compressed Air for Human Respiration |
| CGA G-7.1 | (1997) Commodity Specification for Air |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 701 | (1999) Methods of Fire Tests for Flame-Resistant Textiles and Films |

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

| | |
|---|---|
| NIOSH Pub No. 84-100 | (1984; Supple 1985, 1987, 1988 & 1990) NIOSH Manual of Analytical Methods |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA 340/1-90/018 | (1990) Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance |
| EPA 340/1-90/019 | (1990) Asbestos/NESHAP Adequately Wet Guidance |
| EPA 560/5-85-024 | (1985) Guidance for Controlling Asbestos-Containing Materials in Buildings |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910 | Occupational Safety and Health Standards |
| 29 CFR 1926 | Safety and Health Regulations for Construction |
| 40 CFR 61 | National Emission Standards for Hazardous Air Pollutants |
| 40 CFR 763 | Asbestos |

| | |
|---|---|
| 42 CFR 84 | Approval of Respiratory Protective Devices |
| 49 CFR 107 | Hazardous Materials Program Procedures |
| 49 CFR 171 | General Information, Regulations, and Definitions |
| 49 CFR 172 | Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements |
| 49 CFR 173 | Shippers - General Requirements for Shipments and Packagings |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 586 | (1996; Rev thru Aug 1999) High-Efficiency, Particulate, Air Filter Units |

{AM#0001}
TEXAS DEPARTMENT OF HEALTH

| | |
|---|---|
| {AM#0001}25 TAC | 295.31 to 295.73 |

1.2 DEFINITIONS

a. Adequately Wet: A term defined in 40 CFR 61, Subpart M, and EPA 340/1-90/019 meaning to sufficiently mix or penetrate with liquid to prevent the release of particulate. If visible emissions are observed coming from asbestos-containing material (ACM), then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wetted.

b. Aggressive Method: Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact asbestos-containing material (ACM).

c. Amended Water: Water containing a wetting agent or surfactant with a surface tension of at least 29 dynes per square centimeter when tested in accordance with ASTM D 1331.

d. Asbestos: Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophylite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated and/or altered.

e. Asbestos-Containing Material (ACM): Any materials containing more than one percent asbestos.

f. Asbestos Fiber: A particulate form of asbestos, 5 micrometers or longer, with a length-to-width ratio of at least 3 to 1.

g. Authorized Person: Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

h. Building Inspector: Individual who inspects buildings for asbestos and has EPA Model Accreditation Plan (MAP) "Building Inspector" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

i. Certified Industrial Hygienist (CIH): An Industrial Hygienist certified in the practice of industrial hygiene by the American Board of Industrial Hygiene.

j. Class I Asbestos Work: Activities defined by OSHA involving the removal of thermal system insulation (TSI) and surfacing ACM.

k. Class II Asbestos Work: Activities defined by OSHA involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos - containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic. Certain "incidental" roofing materials such as mastic, flashing and cements when they are still intact are excluded from Class II asbestos work. Removal of small amounts of these materials which would fit into a glovebag may be classified as a Class III job.

l. Class III Asbestos Work: Activities defined by OSHA that involve repair and maintenance operations, where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, cutting a hole, cable pulling, crawling through tunnels or attics and spaces above the ceiling, where asbestos is actively disturbed or asbestos-containing debris is actively disturbed.

m. Class IV Asbestos Work: Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean-up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction.

n. Clean room: An uncontaminated room having facilities for the storage of employees' street clothing and uncontaminated materials and equipment.

o. Competent Person: In addition to the definition in 29 CFR 1926, Section .32(f), a person who is capable of identifying existing asbestos hazards as defined in 29 CFR 1926, Section .1101, selecting the appropriate control strategy, has the authority to take prompt corrective measures to eliminate them and has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

p. Contractor/Supervisor: Individual who supervises asbestos abatement work and has EPA Model Accreditation Plan "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.

q. Critical Barrier: One or more layers of plastic sealed over all openings into a regulated area or any other similarly placed physical barrier sufficient to prevent airborne asbestos in a regulated area from migrating to an adjacent area.

r. Decontamination Area: An enclosed area adjacent and connected to the regulated area and consisting of an equipment room, shower area, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.

s. Demolition: The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

t. Disposal Bag: A 0.15 mm thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926, Section .1101, used for transporting asbestos waste from containment to disposal site.

u. Disturbance: Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in 1 standard sized glovebag or waste bag, not larger than 1.5 m in length and width in order to access a building component.

v. Equipment Room or Area: An area adjacent to the regulated area used for the decontamination of employees and their equipment.

w. Employee Exposure: That exposure to airborne asbestos that would occur if the employee were not using respiratory protective equipment.

x. Fiber: A fibrous particulate, 5 micrometers or longer, with a length to width ratio of at least 3 to 1.

y. Friable ACM: A term defined in 40 CFR 61, Subpart M and EPA 340/1-90/018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. If the asbestos content is less than 10 percent, as determined by a method other than point counting by PLM, the asbestos content is verified by point counting using PLM.

z. Glovebag: Not more than a 1.5 by 1.5 m impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled.

aa. High-Efficiency Particulate Air (HEPA) Filter: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

bb. Homogeneous Area: An area of surfacing material or thermal system insulation that is uniform in color and texture.

cc. Industrial Hygienist: A professional qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational health hazards.

dd. Intact: ACM which has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix. Removal of "intact" asphaltic, resinous, cementitious products does not render the ACM non-intact simply by being separated into smaller pieces.

ee. Model Accreditation Plan (MAP): USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763, Subpart E, Appendix C.

ff. Modification: A changed or altered procedure, material or component of a control system, which replaces a procedure, material or component of a required system.

gg. Negative Exposure Assessment: A demonstration by the Contractor to show that employee exposure during an operation is expected to be consistently below the OSHA Permissible Exposure Limits (PELs).

hh. NESHAP: National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61, Subpart M.

ii. Nonfriable ACM: A NESHAP term defined in 40 CFR 61, Subpart M and EPA 340/1-90/018 meaning any material containing more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy, that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

jj. Nonfriable ACM (Category I): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos as determined using the method specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy.

kk. Nonfriable ACM (Category II): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning any material, excluding Category I nonfriable ACM, containing more than 1 percent asbestos, as determined using the methods specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

ll. Permissible Exposure Limits (PELs):

(1) PEL-Time weighted average(TWA): Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (f/cc) as an 8 hour time weighted average (TWA), as determined by the method prescribed in 29 CFR 1926, Section .1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400.

(2) PEL-Excursion Limit: An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes as determined by the method prescribed in 29 CFR 1926, Section .1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400.

mm. Regulated Area: An OSHA term defined in 29 CFR 1926, Section .1101 meaning an area established by the Contractor to demarcate areas where Class I, II, and III asbestos work is conducted; also any adjoining area where debris and waste from such asbestos work accumulate; and an area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed, the permissible exposure limit.

nn. Removal: All operations where ACM is taken out or stripped from structures or substrates, and includes demolition operations.

oo. Repair: Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM attached to structures or substrates. If the amount of asbestos so "disturbed" cannot be contained in 1 standard glovebag or waste bag, Class I precautions are required.

pp. Spills/Emergency Cleanups: Cleanup of sizable amounts of asbestos waste and debris which has occurred, for example, when water damage occurs in a building, and sizable amounts of ACM are dislodged. A Competent Person evaluates the site and ACM to be handled, and based on the type, condition and extent of the dislodged material, classifies the cleanup as Class I, II, or III. Only if the material was intact and the cleanup involves mere contact of ACM, rather than disturbance, could there be a Class IV classification.

qq. Surfacing ACM: Asbestos-containing material which contains more than 1% asbestos and is sprayed-on, troweled-on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, or other purposes.

rr. Thermal system insulation (TSI) ACM: ACM which contains more than 1% asbestos and is applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain or water condensation.

ss. Transite: A generic name for asbestos cement wallboard and pipe.

tt. Worker: Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926, Section .1101, to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation required by 40 CFR 763, Subpart E, Appendix C, if required by the OSHA Class of work to be performed or by the state where the work is to be performed.

## 1.3 DESCRIPTION OF WORK

The work covered by this section includes the removal of asbestos-containing materials (ACM) which are encountered during demolition activities associated with this project and describes procedures and equipment required to protect workers and occupants of the regulated area from contact with airborne asbestos fibers and ACM dust and debris. Activities include OSHA Class II work operations involving ACM. The work also includes containment, storage, transportation and disposal of the generated ACM wastes. More specific operational procedures shall be detailed in the required Accident Prevention Plan and its subcomponents, the Asbestos Hazard Abatement Plan and Activity Hazard Analyses required in paragraph SAFETY AND HEALTH PROGRAM AND PLANS.

### 1.3.1 Abatement Work Tasks

The specific ACM to be abated is identified on the detailed plans and project drawings. A summary of work task data elements for each individual ACM abatement work task to include the appropriate RESPONSE ACTION DETAIL SHEET (item to be abated and methods to be used) and SET-UP DETAIL SHEETS (containment techniques to include safety precautions and methods) is included in Table 1, "Individual Work Task Data Elements" at the end of this section.

### 1.3.2 Unexpected Discovery of Asbestos

For any previously untested building components suspected to contain asbestos and located in areas impacted by the work, the Contractor shall notify the Contracting Officer (CO) who will have the option of ordering up to 6 bulk samples to be obtained at the Contractor's expense and delivered to a laboratory accredited under the National Institute of Standards and Technology (NIST) "National Voluntary Laboratory Accreditation Program (NVLAP)" and analyzed by PLM at no additional cost to the Government. Any additional components identified as ACM that have been approved by the Contracting Officer for removal shall be removed by the Contractor and will be paid for by an equitable adjustment to the contract price under the CONTRACT CLAUSE titled "changes". Sampling activities undertaken to determine the presence of additional ACM shall be conducted by personnel who have successfully completed the EPA Model Accreditation Plan (MAP) "Building Inspector" training course required by 40 CFR 763, Subpart E, Appendix C.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Respiratory Protection Program; G, RE.

Records of the respirator program.

Cleanup and Disposal; G, RE.

Waste shipment records. Weigh bills and delivery tickets shall be furnished for information only.

Detailed Drawings; G, RE.

Descriptions, detail project drawings, and site layout to include worksite containment area techniques as prescribed on applicable SET-UP DETAIL SHEETS, local exhaust ventilation system locations, decontamination units and load-out units, other temporary waste storage facility, access tunnels, location of temporary utilities (electrical, water, sewer) and boundaries of each regulated area.

Materials and Equipment.

Manufacturer's catalog data for all materials and equipment to be used in the work, including brand name, model, capacity, performance characteristics and any other pertinent information. Test results and certificates from the manufacturer of encapsulants substantiating compliance with performance requirements of this specification. Material Safety Data Sheets for all chemicals to be used onsite in the same format as implemented in the Contractor's HAZARD COMMUNICATION PROGRAM. Data shall include, but shall not be limited to, the following items:

a. High Efficiency Filtered Air (HEPA) local exhaust equipment

b. Vacuum cleaning equipment

c. Pressure differential monitor for HEPA local exhaust equipment

d. Air monitoring equipment

e. Respirators

f. Personal protective clothing and equipment

(1) Coveralls
(2) Underclothing
(3) Other work clothing
(4) Foot coverings
(5) Hard hats
(6) Eye protection
(7) Other items required and approved by Contractors Designated IH and Competent Person

g. Glovebag

h. Duct Tape

i. Disposal Containers

(1) Disposal bags
(2) Fiberboard drums
(3) Paperboard boxes

j. Sheet Plastic

(1) Polyethylene Sheet - General
(2) Polyethylene Sheet - Flame Resistant
(3) Polyethylene Sheet - Reinforced

k. Wetting Agent

(1) Amended Water
(2) Removal encapsulant

l. Strippable Coating

m. Prefabricated Decontamination Unit

n. Other items

o. Chemical encapsulant

p. Chemical encasement materials

q. Material Safety Data Sheets (for all chemicals proposed)

Qualifications; G, RE.

A written report providing evidence of qualifications for personnel, facilities and equipment assigned to the work.

Training Program.

A copy of the written project site-specific training material as indicated in 29 CFR 1926, Section .1101 that will be used to train onsite employees. The training document shall be signed by the Contractor's Designated IH and Competent Person.

Medical Requirements.

Physician's written opinion.

Encapsulants; G, RE.

Certificates stating that encapsulants meet the applicable specified performance requirements.

SD-06 Test Reports

Exposure Assessment and Air Monitoring; G, RE.

Initial exposure assessments, negative exposure assessments, air-monitoring results and documentation.

Local Exhaust Ventilation.

Pressure differential recordings.

Licenses, Permits and Notifications; G, RE.

Licenses, permits, and notifications.

SD-07 Certificates

Vacuum, Filtrationand Ventilation Equipment.

Manufacturer's certifications showing compliance with ANSI Z9.2 for:

a. Vacuums.

b. Water filtration equipment.

c. Ventilation equipment.

d. Other equipment required to contain airborne asbestos fibers.

## 1.5 QUALIFICATIONS

### 1.5.1 Written Qualifications and Organization Report

The Contractor shall furnish a written qualifications and organization report providing evidence of qualifications of the Contractor, Contractor's Project Supervisor, Designated Competent Person, supervisors and workers; Designated IH (person assigned to project and firm name); independent testing laboratory (including name of firm, principal, and analysts who will perform analyses); all subcontractors to be used including disposal transportation and disposal facility firms, subcontractor supervisors, subcontractor workers; and any others assigned to perform asbestos abatement and support activities. The report shall include an organization chart showing the Contractor's staff organization for this project by name and title, chain of command and reporting relationship with all subcontractors. The report shall be signed by the Contractor, the Contractor's onsite project manager, Designated Competent Person, Designated IH, designated testing laboratory and the principals of all subcontractors to be used. The Contractor shall include the following statement in the report: "By signing this report I certify that the personnel I am responsible for during the course of this project fully understand the contents of 29 CFR 1926, Section .1101, 40 CFR 61, Subpart M, and the federal, state and local requirements specified in paragraph SAFETY AND HEALTH PROGRAM AND PLANS for those asbestos abatement activities that they will be involved in."

1.5.2 Specific Requirements

The Contractor shall designate in writing, personnel meeting the following qualifications:

a. Designated Competent Person: The name, address, telephone number, and resume of the Contractor's Designated Competent Person shall be provided. Evidence that the full-time Designated Competent Person is qualified in accordance with 29 CFR 1926, Sections .32 and .1101, has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C, licensed by the Texas Department of Health (TDH) and is experienced in the administration and supervision of asbestos abatement projects, including exposure assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite, etc. The duties of the Competent Person shall include the following: controlling entry to and exit from the regulated area; supervising any employee exposure monitoring required by 29 CFR 1926, Section .1101; ensuring that all employees working within a regulated area wear the appropriate personal protective equipment (PPE), are trained in the use of appropriate methods of exposure control, and use the hygiene facilities and decontamination procedures specified; and ensuring that engineering controls in use are in proper operating conditions and are functioning properly. The Designated Competent Person shall be responsible for compliance with applicable federal, state and local requirements, the Contractor's Accident Prevention Plan and Asbestos Hazard Abatement Plan. The Designated Competent Person shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Contractor shall submit evidence that this person has a minimum of 2 years of on-the-job asbestos abatement experience relevant to OSHA competent person requirements. The Designated Competent Person shall be onsite at all times during the conduct of this project.

b. Project and Other Supervisors: The Contractor shall provide the name, address, telephone number, and resume of the Project Supervisor and other supervisors who have responsibility to implement the Accident Prevention Plan, including the Asbestos Hazard Abatement Plan and Activity Hazard Analyses, the authority to direct work performed under this contract and verify compliance, and have EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C. The Project Supervisor and other supervisors shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph and the TDH License. The Contractor shall submit evidence that the Project Supervisor has a minimum of 2 years] of on-the-job asbestos abatement experience relevant to project supervisor responsibilities and the other supervisors have a minimum of 1 year on-the-job asbestos abatement experience commensurate with the responsibilities they will have on this project.

c. Designated Industrial Hygienist: The Contractor shall provide the name, address, telephone number, resume and other information specified below for the Industrial Hygienist (IH) selected to prepare the Contractor's Asbestos Hazard Abatement Plan, prepare and perform training, direct air monitoring and assist the Contractor's Competent Person in implementing and ensuring that safety and health requirements are complied with during the performance of all required work. The Designated IH shall be a person who is board certified in the practice of industrial hygiene as determined and documented by the American Board of Industrial Hygiene (ABIH), has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C, and has a minimum of 3 years of comprehensive experience in planning and overseeing asbestos abatement activities. The Designated IH shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Designated IH shall be completely independent from the Contractor according to federal, state, or local regulations; that is, shall not be a Contractor's employee or be an employee or principal of a firm in a business relationship with the Contractor negating such independent status. A copy of the Designated IH's current valid ABIH certification shall be included. The Designated IH shall visit the site at least 1 time per week for the duration of asbestos activities and shall be available for emergencies. In addition, the Designated IH shall prepare, and the Contractor shall submit, the name, address, telephone numbers and resumes of additional IH's and industrial hygiene technicians (IHT) who will be assisting the Designated IH in performing onsite tasks. IHs and IHTs supporting the Designated IH shall have a minimum of 2 years of practical onsite asbestos abatement experience and have a TDH license for Project Manager. The formal reporting relationship between the Designated IH and the support IHs and IHTs, the Designated Competent Person, and the Contractor shall be indicated.

d. Asbestos Abatement Workers: Asbestos abatement workers shall meet the requirements contained in 29 CFR 1926, Section .1101, 40 CFR 61, Subpart M, and other applicable federal, state and local requirements. Worker training documentation shall be provided as required on the "Certificate of Workers Acknowledgment" in this paragraph.

e. Worker Training and Certification of Worker Acknowledgment: Training documentation will be required for each employee who will perform OSHA Class I, Class II, Class III, or Class IV asbestos abatement operations. Such documentation shall be submitted on a Contractor generated form titled "Certificate of Workers Acknowledgment", to be completed for each employee in the same format and containing the same information as the example certificate at the end of this section. Training course completion certificates (initial and most recent update refresher) required by the information checked on the form shall be attached.

f. Physician: The Contractor shall provide the name, medical qualifications, address, telephone number and resume of the physician who will or has performed the medical examinations and evaluations of the persons who will conduct the asbestos abatement work tasks. The physician shall be currently licensed by the state where the workers will be or have been examined, have expertise in pneumoconiosis and shall be responsible for the determination of medical surveillance protocols and for review of examination/test results performed in compliance with 29 CFR 1926, Section .1101 and paragraph MEDICAL REQUIREMENTS. The physician shall be familiar with the site's hazards and the scope of this project.

g. First Aid and CPR Trained Persons: The names of at least 2 persons who are currently trained in first aid and CPR by the American Red Cross or other approved agency shall be designated and shall be onsite at all times during site operations. They shall be trained in universal precautions and the use of PPE as described in the Bloodborne Pathogens Standard of 29 CFR 1910, Section .1030 and shall be included in the Contractor's Bloodborne Pathogen Program. These persons may perform other duties but shall be immediately available to render first aid when needed. A copy of each designated person's current valid First Aid and CPR certificate shall be provided.

h. Independent Testing Laboratory: The Contractor shall provide the name, address and telephone number of the independent testing laboratory selected to perform the sample analyses and report the results. The testing laboratory shall be completely independent from the Contractor as recognized by federal, state or local regulations. Written verification of the following criteria, signed by the testing laboratory principal and the Contractor, shall be submitted:

(1) Phase contrast microscopy (PCM): The laboratory is fully equipped and proficient in conducting PCM of airborne samples using the methods specified by 29 CFR 1926, Section .1101, OSHA method ID-160, the most current version of NIOSH Pub No. 84-100 Method 7400, and NIOSH Pub No. 84-100 Method 7402, transmission electron microscopy (TEM); the laboratory is currently judged proficient (classified as acceptable) in counting airborne asbestos samples by PCM by successful participation in each of the last 4 rounds in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program; the names of the selected microscopists who will analyze airborne samples by PCM with verified documentation of their proficiency to conduct PCM analyses by being judged proficient in counting samples as current participating analysts in the AIHA PAT Program, and having successfully completed the Asbestos Sampling and Analysis course (NIOSH 582 or equivalent) with a copy of course completion certificate provided; when the PCM analysis is to be conducted onsite, documentation shall be provided certifying that the onsite analyst meets the same requirements.

(2) Polarized light microscopy (PLM): The laboratory is fully equipped and proficient in conducting PLM analyses of suspect ACM bulk samples in accordance with 40 CFR 763, Subpart E, Appendix E; the laboratory is currently accredited by NIST under the NVLAP for bulk asbestos analysis and will use analysts (names shall be provided) with demonstrated proficiency to conduct PLM to include its application to the identification and quantification of asbestos content.

(3) Transmission electron microscopy (TEM): The laboratory is fully equipped and proficient in conducting TEM analysis of airborne samples using the mandatory method specified by 40 CFR 763, Subpart E, Appendix E; the laboratory is currently accredited by NIST under the NVLAP for airborne sample analysis of asbestos by TEM; the laboratory will use analysts (names shall be provided) that are currently evaluated as competent with demonstrated proficiency under the NIST NVLAP for airborne sample analysis of asbestos by TEM.

(4) PCM/TEM: The laboratory is fully equipped and each analyst (name shall be provided) possesses demonstrated proficiency in conducting PCM and TEM analysis of airborne samples using NIOSH Pub No. 84-100Method 7400 PCM and NIOSH Pub No. 84-100 Method 7402 (TEM confirmation of asbestos content of PCM results) from the same filter.

i. Disposal Facility, Transporter: The Contractor shall provide written evidence that the landfill to be used is approved for asbestos disposal by the USEPA and state regulatory agencies.

Copies of signed agreements between the Contractor (including subcontractors and transporters) and the asbestos waste disposal facility to accept and dispose of all asbestos containing waste generated during the performance of this contract shall be provided. Qualifications shall be provided for each subcontractor or transporter to be used, indicating previous experience in transport and disposal of asbestos waste to include all required state and local waste hauler requirements for asbestos. The Contractor and transporters shall meet the DOT requirements of 49 CFR 171, 49 CFR 172, and 49 CFR 173 as well as registration requirements of 49 CFR 107 and other applicable state or local requirements. The disposal facility shall meet the requirements of 40 CFR 61, Sections .154 or .155, as required in 40 CFR 61, Section .150(b), and other applicable state or local requirements.

### 1.5.3 Federal, State or Local Citations on Previous Projects

The Contractor and all subcontractors shall submit a statement, signed by an officer of the company, containing a record of any citations issued by Federal, State or local regulatory agencies relating to asbestos activities (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for terminations). If there are none, a negative declaration signed by an officer of the company shall be provided.

## 1.6 REGULATORY REQUIREMENTS

In addition to detailed requirements of this specification, work performed under this contract shall comply with EM 385-1-1, applicable federal, state, and local laws, ordinances, criteria, rules and regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. This includes, but is not limited to, OSHA standards, 29 CFR 1926, especially Section .1101, 40 CFR 61, Subpart M and 40 CFR 763. Matters of interpretation of standards shall be submitted to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply. The following state and local laws, rules and regulations regarding demolition, removal, encapsulation, construction alteration, repair, maintenance, renovation, spill/emergency cleanup, housekeeping, handling, storing, transporting and disposing of asbestos material apply: Texas Asbestos Health Protection Rules

## 1.7 SAFETY AND HEALTH PROGRAM AND PLANS

The Contractor shall develop and submit a written comprehensive site-specific Accident Prevention Plan at least 30 days prior to the preconstruction conference. The Accident Prevention Plan shall address requirements of EM 385-1-1, Appendix A, covering onsite work to be performed by the Contractor and subcontractors. The Accident Prevention Plan shall incorporate an Asbestos Hazard Abatement Plan, and Activity

Hazard Analyses as separate appendices into 1 site specific Accident Prevention Plan document. Any portions of the Contractor's overall Safety and Health Program that are referenced in the Accident Prevention Plan, e.g., respirator program, hazard communication program, confined space entry program, etc., shall be included as appendices to the Accident Prevention Plan. The plan shall take into consideration all the individual asbestos abatement work tasks identified in Table 1. The plan shall be prepared, signed (and sealed, including certification number if required), and dated by the Contractor's Designated IH, Competent Person, and Project Supervisor.

1.7.1 Asbestos Hazard Abatement Plan Appendix

The Asbestos Hazard Abatement Plan appendix to the Accident Prevention Plan shall include, but not be limited to, the following:

a. The personal protective equipment to be used;

b. The location and description of regulated areas including clean and dirty areas,access tunnels, and decontamination unit (clean room, shower room, equipment room, storage areas such as load-out unit);

c. Initial exposure assessment in accordance with 29 CFR 1926, Section .1101;

d. Level of supervision;

e. Method of notification of other employers at the worksite;

f. Abatement method to include containment and control procedures;

g. Interface of trades involved in the construction;

h. Sequencing of asbestos related work;

i. Storage and disposal procedures and plan;

j. Type of wetting agent and asbestos encapsulant to be used;

k. Location of local exhaust equipment;

l. Air monitoring methods (personal, environmental and clearance);

m. Bulk sampling and analytical methods (if required);

n. A detailed description of the method to be employed in order to control the spread of ACM wastes and airborne fiber concentrations;

o. Fire and medical emergency response procedures;

p. The security procedures to be used for all regulated areas.

1.7.2 Activity Hazard Analyses Appendix

Activity Hazard Analyses, for each major phase of work, shall be submitted and updated during the project. The Activity Hazard Analyses format shall be in accordance with EM 385-1-1 (Figure 1-1). The analysis shall define the activities to be performed for a major phase of work, identify the sequence of work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level. Work shall not proceed on that phase until the Activity Hazard Analyses has been accepted and a preparatory meeting has been conducted by the Contractor to discuss its contents with everyone engaged in the activities, including the onsite Government representatives. The Activity Hazard Analyses shall be continuously reviewed and, when appropriate, modified to address changing site conditions or operations.

## 1.8 PRECONSTRUCTION CONFERENCE AND ONSITE SAFETY

The Contractor and the Contractor's Designated Competent Person, Project Supervisor, and Designated IH shall meet with the Contracting Officer prior to beginning work at a safety preconstruction conference to discuss the details of the Contractor's submitted Accident Prevention Plan to include the Asbestos Hazard Abatement Plan and Activity Hazard Analyses appendices. Deficiencies in the Accident Prevention Plan will be discussed and the Accident Prevention Plan shall be revised to correct the deficiencies and resubmitted for acceptance. Any changes required in the specification as a result of the Accident Prevention Plan shall be identified specifically in the plan to allow for free discussion and acceptance by the Contracting Officer, prior to the start of work. Onsite work shall not begin until the Accident Prevention Plan has been accepted. A copy of the written Accident Prevention Plan shall be maintained onsite. Changes and modifications to the accepted Accident Prevention Plan shall be made with the knowledge and concurrence of the Designated IH, the Project Supervisor, Designated Competent Person, and the Contracting Officer. Should any unforeseen hazard become evident during the performance of the work, the Designated IH shall bring such hazard to the attention of the Project Supervisor, Designated Competent Person, and the Contracting Officer, both verbally and in writing, for resolution as soon as possible. In the interim, all necessary action shall be taken by the Contractor to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Once accepted by the Contracting Officer, the Accident Prevention Plan, including the Asbestos Hazard Abatement Plan and Activity Hazard Analyses will be enforced as if an addition to the contract. Disregarding the provisions of this contract or the accepted Accident Prevention Plan will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified.

## 1.9 SECURITY

Fenced and locked security area shall be provided for each regulated area. A log book shall be kept documenting entry into and out of the regulated area. Entry into regulated areas shall only be by personnel authorized by the Contractor and the Contracting Officer. Personnel authorized to enter regulated areas shall be trained, be medically evaluated, and wear the required personal protective equipment for the specific regulated area to be entered.

## 1.10 MEDICAL REQUIREMENTS

Medical requirements shall conform to 29 CFR 1926, Section .1101.

### 1.10.1 Medical Examinations

Before being exposed to airborne asbestos fibers, workers shall be provided with a medical examination as required by 29 CFR 1926, Section .1101 and other pertinent state or local requirements. This requirement shall have been satisfied within the last 12 months. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. X-ray films of asbestos workers shall be identified to the consulting radiologist and medical record jackets shall be marked with the word "asbestos."

#### 1.10.1.1 Information Provided to the Physician

The Contractor shall provide the following information in writing to the examining physician:

a. A copy of 29 CFR 1926, Section .1101 and Appendices D, E, G, and I;

b. A description of the affected employee's duties as they relate to the employee's exposure;

c. The employee's representative exposure level or anticipated exposure level;

d. A description of any personal protective and respiratory equipment used or to be used;

e. Information from previous medical examinations of the affected employee that is not otherwise available to the examining physician.

#### 1.10.1.2 Written Medical Opinion

For each worker, a written medical opinion prepared and signed by a licensed physician indicating the following:

a. Summary of the results of the examination.

b. The potential for an existing physiological condition that would place the employee at an increased risk of health impairment from exposure to asbestos.

c. The ability of the individual to wear personal protective equipment, including respirators, while performing strenuous work tasks under cold and/or heat stress conditions.

d. A statement that the employee has been informed of the results of the examination, provided with a copy of the results, informed of the increased risk of lung cancer attributable to the combined effect of smoking and asbestos exposure, and informed of any medical condition that may result from asbestos exposure.

1.10.2 Medical and Exposure Records

Complete and accurate records shall be maintained of each employee's medical examinations, medical records, and exposure data, as required by 29 CFR 1910, Section .1910.20 and 29 CFR 1926, Section .1101 for a period of 50 years after termination of employment. Records of the required medical examinations and exposure data shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health (OSHA) or authorized representatives of the employee and an employee's physician upon request of the employee or former employee. A copy of the required medical certification for each employee shall be maintained on file at the worksite for review, as requested by the Contracting Officer or the representatives.

1.11 TRAINING PROGRAM

1.11.1 General Training Requirements

The Contractor shall establish a training program as specified by EPA Model Accreditation Plan (MAP), training requirements at 40 CFR 763, Subpart E, Appendix C, the State of Texas regulation no. 25 TAC 289.141 - 289.156, OSHA requirements at 29 CFR 1926, Section .1101(k)(9), and this specification. Contractor employees shall complete the required training for the type of work they are to perform and such training shall be documented and provided to the Contracting Officer as specified in paragraph QUALIFICATIONS.

1.11.2 Project Specific Training

Prior to commencement of work, each worker shall be instructed by the Contractor's Designated IH and Competent Person in the following project specific training:

a. The hazards and health effects of the specific types of ACM to be abated;

b. The content and requirements of the Contractor's Accident Prevention Plan to include the Asbestos Hazard Abatement Plan and Activity Hazard Analyses and site-specific safety and health precautions;

c. Hazard Communication Program;

d. Hands-on training for each asbestos abatement technique to be employed;

e. Heat and/or cold stress monitoring specific to this project;

f. Air monitoring program and procedures;

g. Medical surveillance to include medical and exposure record-keeping procedures;

h. The association of cigarette smoke and asbestos-related disease;

i. Security procedures;

j. Specific work practice controls and engineering controls required for each Class of work in accordance with 29 CFR 1926, Section .1101.

1.12 RESPIRATORY PROTECTION PROGRAM

The Contractor's Designated IH shall establish in writing, and implement a respiratory protection program in accordance with 29 CFR 1926, Section .1101, 29 CFR 1910, Section .134, ANSI Z88.2, CGA G-7, CGA G-7.1 . The Contractor's Designated IH shall establish minimum respiratory protection requirements based on measured or anticipated levels of airborne asbestos fiber concentrations encountered during the performance of the asbestos abatement work. The Contractor's respiratory protection program shall include, but not be limited to, the following elements:

a. The company policy, used for the assignment of individual responsibility, accountability, and implementation of the respiratory protection program.

b. The standard operating procedures covering the selection and use of respirators. Respiratory selection shall be determined by the hazard to which the worker is exposed.

c. Medical evaluation of each user to verify that the worker may be assigned to an activity where respiratory protection is required.

d. Training in the proper use and limitations of respirators.

e. Respirator fit-testing, i.e., quantitative, qualitative and individual functional fit checks.

f. Regular cleaning and disinfection of respirators.

g. Routine inspection of respirators during cleaning and after each use when designated for emergency use.

h. Storage of respirators in convenient, clean, and sanitary locations.

i. Surveillance of regulated area conditions and degree of employee exposure (e.g., through air monitoring).

j. Regular evaluation of the continued effectiveness of the respiratory protection program.

k. Recognition and procedures for the resolution of special problems as they affect respirator use (e.g., no facial hair that comes between the respirator face piece and face or interferes with valve function; prescription eye wear usage; contact lenses usage; etc.).

l. Proper training in putting on and removing respirators.

1.12.1 Respiratory Fit Testing

A qualitative or quantitative fit test conforming to 29 CFR 1926, Section 1101, Appendix C shall be conducted by the Contractor's Designated IH for each Contractor worker required to wear a respirator, and for the Contracting Officer and authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test shall be performed for each worker wearing a negative-pressure respirator prior to initially wearing a respirator on this project and every 6 months thereafter. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, or of full-facepiece air purifying respirators where they are worn at levels at which half-facepiece air purifying respirators are permitted. If physical changes develop that will affect the fit, a new fit test for the worker shall be performed. Functional fit checks shall be performed by employees each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.12.2 Respirator Selection and Use Requirements

The Contractor shall provide respirators, and ensure that they are used as required by 29 CFR 1926, Section .1101 and in accordance with the manufacturer's recommendations. Respirators shall be jointly approved by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (MSHA/NIOSH), or by NIOSH, under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. Personnel who handle ACM, enter regulated areas that require the wearing of a respirator, or who are otherwise carrying out abatement activities that require the wearing of a respirator, shall be provided with approved respirators that are fully protective of the worker at the measured or anticipated airborne asbestos concentration level to be encountered. For air-purifying respirators, the particulate filter portion of the cartridges or canister approved for use in airborne asbestos environments shall be high-efficiency particulate air (HEPA). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type shall be made by the Contractor's Designated IH based on the measured or anticipated airborne asbestos fiber concentrations to be encountered. Recommendations made by the Contractor's Designated IH to downgrade respirator type shall be submitted in writing to the Contracting Officer. The Contractor's Designated Competent Person in consultation with the Designated IH, shall have the authority to take immediate action to upgrade or downgrade respiratory type when there is an immediate danger to the health and safety of the wearer. Respirators shall be used in the following circumstances:

a. During all Class I asbestos jobs.

b. During all Class II work where the ACM is not removed in a substantially intact state.

c. During all Class II and III work which is not performed using wet methods. Respirators need not be worn during removal of ACM from sloped roofs when a negative exposure assessment has been made and ACM is removed in an intact state.

d. During all Class II and III asbestos jobs where the Contractor does not produce a negative exposure assessment.

e. During all Class III jobs where TSI or surfacing ACM is being disturbed.

f. During all Class IV work performed within regulated areas where employees performing other work are required to wear respirators.

g. During all work where employees are exposed above the PEL-TWA or PEL-Excursion Limit.

h. In emergencies

1.12.3 Class I Work

The Contractor shall provide: (1) a tight-fitting, powered air purifying respirator equipped with high efficiency filters, or (2) a full-facepiece supplied air respirator operated in the pressure demand mode, equipped with HEPA egress cartridges, or (3) an auxiliary positive pressure self-contained breathing apparatus, for all employees within the regulated area where Class I work is being performed; provided that a negative exposure assessment has not been produced, and that the exposure level will not exceed 1 f/cc as an 8-hour time weighted average. A full-facepiece supplied air respirator, operated in the pressure demand mode, equipped with an auxiliary positive pressure self-contained breathing apparatus shall be provided under such conditions, if the exposure assessment indicates exposure levels above 1 f/cc as an 8-hour time weighted average.

1.12.4 Class II and III Work

The Contractor shall provide an air purifying respirator, other than a disposable respirator, equipped with high-efficiency filters whenever the employee performs Class II and III asbestos jobs where the Contractor does not produce a negative exposure assessment ; and Class III jobs where TSI or surfacing ACM is being disturbed.

1.12.5 Sanitation

Employees who wear respirators shall be permitted to leave work areas to wash their faces and respirator facepieces whenever necessary to prevent skin irritation associated with respirator use.

1.13 HAZARD COMMUNICATION PROGRAM

A hazard communication program shall be established and implemented in accordance with 29 CFR 1926, Section .59. Material safety data sheets

(MSDSs) shall be provided for all hazardous materials brought onto the worksite. One copy shall be provided to the Contracting Officer and 1 copy shall be included in the Contractor's Hazard Communication Program.

## 1.14 LICENSES, PERMITS AND NOTIFICATIONS

### 1.14.1 General Legal Requirements

Necessary licenses, permits and notifications shall be obtained in conjunction with the project's asbestos abatement, transportation and disposal actions and timely notification furnished of such actions as required by federal, state, regional, and local authorities. The Contractor shall notify the the Texas Department of Health and the Contracting Officer in writing, at least 10 working days prior to the commencement of work, in accordance with 40 CFR 61, Subpart M, and state and local requirements to include the mandatory "Notification of Demolition and Renovation Record" form and other required notification documents. Notification shall be by Certified Mail, Return Receipt Requested. The Contractor shall furnish copies of the receipts to the Contracting Officer, in writing, prior to the commencement of work. Local fire department shall be notified 3 days before fire-proofing material is removed from a building and the notice shall specify whether or not the material contains asbestos. A copy of the rental company's written acknowledgment and agreement shall be provided as required by paragraph RENTAL EQUIPMENT. For licenses, permits, and notifications that the Contractor is responsible for obtaining, the Contractor shall pay any associated fees or other costs incurred.

### 1.14.2 Litigation and Notification

The Contractor shall notify the Contracting Officer if any of the following occur:

a. The Contractor or any of the subcontractors are served with notice of violation of any law, regulation, permit or license which relates to this contract;

b. Proceedings are commenced which could lead to revocation of related permits or licenses; permits, licenses or other Government authorizations relating to this contract are revoked;

c. Litigation is commenced which would affect this contract;

d. The Contractor or any of the subcontractors become aware that their equipment or facilities are not in compliance or may fail to comply in the future with applicable laws or regulations.

## 1.15 PERSONAL PROTECTIVE EQUIPMENT

Three complete sets of personal protective equipment shall be made available to the Contracting Officer and authorized visitors for entry to the regulated area. Contracting Officer and authorized visitors shall be provided with training equivalent to that provided to Contractor employees in the selection, fitting, and use of the required personal protective equipment and the site safety and health requirements. Contractor workers shall be provided with personal protective clothing and equipment and the Contractor shall ensure that it is worn properly. The Contractor's Designated IH and Designated Competent Person shall select and approve all the required personal protective clothing and equipment to be used.

1.15.1 Respirators

Respirators shall be in accordance with paragraph RESPIRATORY PROTECTION PROGRAM.

1.15.2 Whole Body Protection

Personnel exposed to airborne concentrations of asbestos that exceed the PELs, or for all OSHA Classes of work for which a required negative exposure assessment is not produced, shall be provided with whole body protection and such protection shall be worn properly. The Contractor's Designated IH and Competent Person shall select and approve the whole body protection to be used. The Competent Person shall examine work suits worn by employees at least once per work shift for rips or tears that may occur during performance of work. When rips or tears are detected while an employee is working, rips and tears shall be immediately mended, or the work suit shall be immediately replaced. Disposable whole body protection shall be disposed of as asbestos contaminated waste upon exiting from the regulated area. Reusable whole body protection worn shall be either disposed of as asbestos contaminated waste upon exiting from the regulated area or be properly laundered in accordance with 29 CFR 1926, Section .1101. Whole body protection used for asbestos abatement shall not be removed from the worksite by a worker to be cleaned. Recommendations made by the Contractor's Designated IH to downgrade whole body protection shall be submitted in writing to the Contracting Officer. The Contractor's Designated Competent Person, in consultation with the Designated IH, has the authority to take immediate action to upgrade or downgrade whole body protection when there is an immediate danger to the health and safety of the wearer.

1.15.2.1 Coveralls

Disposable-breathable coveralls with a zipper front shall be provided. Sleeves shall be secured at the wrists, and foot coverings secured at the ankles.

1.15.2.2 Underwear

Disposable underwear shall be provided. If reusable underwear are used, they shall be disposed of as asbestos contaminated waste or laundered in accordance with 29 CFR 1926, Section .1101. Asbestos abatement workers shall not remove contaminated reusable underwear worn during abatement of ACM from the site to be laundered.

1.15.2.3 Work Clothing

An additional coverall shall be provided when the abatement and control method employed does not provide for the exit from the regulated area directly into an attached decontamination unit. Cloth work clothes for wear under the protective coverall, and foot coverings, shall be provided when work is being conducted in low temperature conditions. Cloth work clothes shall be either disposed of as asbestos contaminated waste or properly laundered in accordance with 29 CFR 1926, Section .1101.

1.15.2.4 Gloves

Gloves shall be provided to protect the hands. Where there is the potential for hand injuries (i.e., scrapes, punctures, cuts, etc.) a suitable glove shall be provided and used.

1.15.2.5 Foot Coverings

Cloth socks shall be provided and worn next to the skin. Footwear, as required by OSHA and EM 385-1-1, that is appropriate for safety and health hazards in the area shall be worn. Rubber boots shall be used in moist or wet areas. Reusable footwear removed from the regulated area shall be thoroughly decontaminated or disposed of as ACM waste. Disposable protective foot covering shall be disposed of as ACM waste. If rubber boots are not used, disposable foot covering shall be provided.

1.15.2.6 Head Covering

Hood type disposable head covering shall be provided. In addition, protective head gear (hard hats) shall be provided as required. Hard hats shall only be removed from the regulated area after being thoroughly decontaminated.

1.15.2.7 Protective Eye Wear

Eye protection provided shall be in accordance with ANSI Z87.1.

1.16 HYGIENE FACILITIES AND PRACTICES

The Contractor shall establish a decontamination area for the decontamination of employees, material and equipment. The Contractor shall ensure that employees enter and exit the regulated area through the decontamination area.

1.16.1 Shower Facilities

Shower facilities, when provided, shall comply with 29 CFR 1910, Section .141(d)(3).

1.16.2 3-Stage Decontamination Area

A temporary negative pressure decontamination unit that is adjacent and attached in a leak-tight manner to the regulated area shall be provided as described in applicable requlations. The decontamination unit shall have an equipment room and a clean room separated by a shower that complies with 29 CFR 1910, Section .141 (unless the Contractor can demonstrate that such facilities are not feasible). Equipment and surfaces of containers filled with ACM shall be cleaned prior to removing them from the equipment room or area. Surfaces of the equipment room shall be wet wiped 2 times after each shift. Materials used for wet wiping shall be disposed of as asbestos contaminated waste. Two separate lockers shall be provided for each asbestos worker, one in the equipment room and one in the clean room. Hot water service may be secured from the building hot water system provided backflow protection is installed by the Contractor at the point of connection. Should sufficient hot water be unavailable, the Contractor shall provide a minimum 160 L electric water heater with minimum recovery rate of 80 L per hour and a temperature controller for each showerhead. The Contractor shall provide a minimum of 2 showers. Instantaneous type in-line water heater may be incorporated at each shower head in lieu of hot water heater, upon approval by the Contracting Officer. Flow and temperature controls shall be located within the shower and shall be adjustable by the user. The wastewater pump shall be sized for 1.25 times the showerhead flow-rate at a pressure head sufficient to satisfy the filter head loss and discharge line losses. The pump shall supply a minimum 1.6 L/s flow with 10.7 m of pressure head. Used shower water shall be collected and filtered to remove asbestos contamination. Filters and residue shall be disposed of as asbestos contaminated material. Filtered water shall be discharged to the sanitary system. Wastewater filters shall be installed in series with the first stage pore size of 20 microns and the second stage pore size of 5 microns. The floor of the decontamination unit's clean room shall be kept dry and clean at all times. Water from the shower shall not be allowed to wet the floor in the clean room. Surfaces of the clean room and shower shall be wet-wiped 2 times after each shift change with a disinfectant solution. Proper housekeeping and hygiene requirements shall be maintained. Soap and towels shall be provided for showering, washing and drying. Any cloth towels provided shall be disposed of as ACM waste or shall be laundered in accordance with 29 CFR 1926, Section .1101.

### 1.16.3 Load-Out Unit

A temporary load-out unit that is adjacent and connected to the regulated area and access tunnel shall be provided . Utilization of prefabricated units shall have prior approval of the Contracting Officer. The load-out unit shall be attached in a leak-tight manner to each regulated area. Surfaces of the load-out unit and access tunnel shall be adequately wet-wiped 2 times after each shift change. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

### 1.16.4 Single Stage Decontamination Area

A decontamination area (equipment room/area) shall be provided for Class I work involving less than 7.5 m or 0.9 square meters of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed the PELs or where there is no negative exposure assessment produced before the operation. The equipment room or area shall be adjacent to the regulated area for the decontamination of employees, material, and their equipment which is contaminated with asbestos. The equipment room or area shall consist of an area covered by an impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area.

Surfaces of the equipment room shall be wet wiped 2 times after each shift. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

1.16.5 Decontamination Requirements for Class IV Work

The Contractor shall ensure that employees performing Class IV work within a regulated area comply with the hygiene practice required of employees performing work which has a higher classification within that regulated area, or the Contractor shall provide alternate decontamination area facilities for employees cleaning up debris and material which is TSI or surfacing ACM.

1.16.6 Decontamination Area Entry Procedures

The Contractor shall ensure that employees entering the decontamination area through the clean room or clean area:

a. Remove street clothing in the clean room or clean area and deposit it in lockers.

b. Put on protective clothing and respiratory protection before leaving the clean room or clean area.

c. Pass through the equipment room to enter the regulated area.

1.16.7 Decontamination Area Exit Procedures

The Contractor shall ensure that the following procedures are followed:

a. Before leaving the regulated area, respirators shall be worn while employees remove all gross contamination and debris from their work clothing using a HEPA vacuum.

b. Employees shall remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers for disposal and/or laundering.

c. Employees shall not remove their respirators in the equipment room.

d. Employees shall shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, the Contractor shall ensure that employees engaged in Class I asbestos jobs: a) Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or b) Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.

e. After showering, employees shall enter the clean room before changing into street clothes.

1.16.8 Lunch Areas

The Contractor shall provide lunch areas in which the airborne concentrations of asbestos are below 0.01 f/cc.

1.16.9 Smoking

Smoking, if allowed by the Contractor, shall only be permitted in designated areas approved by the Contracting Officer.

## 1.17 REGULATED AREAS

All Class I, II, and III asbestos work shall be conducted within regulated areas. The regulated area shall be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Where critical barriers or negative pressure enclosures are used, they shall demarcate the regulated area. Access to regulated areas shall be limited to authorized persons. The Contractor shall control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

## 1.18 WARNING SIGNS AND TAPE

Warning signs and tape printed bilingually in English and Spanish shall be provided at the regulated boundaries and entrances to regulated areas. The Contractor shall ensure that all personnel working in areas contiguous to regulated areas comprehend the warning signs. Signs shall be located to allow personnel to read the signs and take the necessary protective steps required before entering the area. Warning signs, shall be in vertical format conforming to 29 CFR 1910 and 29 CFR 1926, Section .1101, a minimum of 500 by 350 mm , and displaying the following legend in the lower panel:

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

Spacing between lines shall be at least equal to the height of the upper of any two lines. Warning tape shall be provided. Decontamination unit signage shall be as shown and described above.

## 1.19 WARNING LABELS

Warning labels shall be affixed to all asbestos disposal containers used to contain asbestos materials, scrap, waste debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to requirements are acceptable. Warning labels shall conform to 29 CFR 1926, Section .1101 and shall be of sufficient size to be clearly legible displaying the following legend:

DANGER

CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

## 1.20 LOCAL EXHAUST VENTILATION

Local exhaust ventilation units shall conform to ANSI Z9.2 and 29 CFR 1926, Section .1101. Filters on local exhaust system equipment shall conform to ANSI Z9.2 and UL 586. Filter shall be UL labeled.

## 1.21 TOOLS

Vacuums shall be leak proof to the filter, equipped with HEPA filters, of sufficient capacity and necessary capture velocity at the nozzle or nozzle attachment to efficiently collect, transport and retain the ACM waste material. Power tools shall not be used to remove ACM unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation capture and collection system, or has otherwise been approved for use by the Contracting Officer. Residual asbestos shall be removed from reusable tools prior to storage and reuse. Reusable tools shall be thoroughly decontaminated prior to being removed from regulated areas.

## 1.22 RENTAL EQUIPMENT

If rental equipment is to be used, written notification shall be provided to the rental agency, concerning the intended use of the equipment, the possibility of asbestos contamination of the equipment and the steps that will be taken to decontaminate such equipment. A written acceptance of the terms of the Contractor's notification shall be obtained from the rental agency.

## 1.23 AIR MONITORING EQUIPMENT

The Contractor's Designated IH shall approve air monitoring equipment to be used to collect samples. The equipment shall include, but shall not be limited to:

a. High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute when equipped with a sampling train of tubing and filter cassette.

b. Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute when equipped with a sampling train of tubing and filter cassette, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps shall also be equipped with an automatic flow control unit which shall maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.

c. Single use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands, to be used with low flow pumps in accordance with 29 CFR 1926, Section .1101 for personal air sampling.

d. Single use standard 25 mm diameter cassette, open face, 0.45 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive cowl, and shrink bands, to be used with high flow pumps when conducting environmental area sampling using NIOSH Pub No. 84-100 Methods 7400 and 7402.

e. Appropriate plastic tubing to connect the air sampling pump to the selected filter cassette.

f. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 20 to plus 60 degrees C and traceable to a NIST primary standard.

## 1.24 EXPENDABLE SUPPLIES

### 1.24.1 Glovebag

Glovebags shall be provided as described in 29 CFR 1926, Section .1101. The glovebag assembly shall be 0.15 mm thick plastic, prefabricated and seamless at the bottom with preprinted OSHA warning label.

### 1.24.2 Duct Tape

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container shall be provided.

### 1.24.3 Disposal Containers

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers shall be provided for ACM wastes as required by 29 CFR 1926 Section .1101 .

### 1.24.4 Disposal Bags

Leak-tight bags, 0.15 mm thick, shall be provided for placement of asbestos generated waste.

### 1.24.5 Sheet Plastic

Sheet plastic shall be polyethylene of 0.15 mm minimum thickness and shall be provided in the largest sheet size necessary to minimize seams ,as indicated on the project drawings. Film shall be [frosted and conform to ASTM D 4397, except as specified below:

#### 1.24.5.1 Flame Resistant

Where a potential for fire exists, flame-resistant sheets shall be provided. Film shall be frosted] and shall conform to the requirements of NFPA 701.

1.24.5.2 Reinforced

Reinforced sheets shall be provided where high skin strength is required, such as where it constitutes the only barrier between the regulated area and the outdoor environment. The sheet stock shall consist of translucent, nylon-reinforced or woven-polyethylene thread laminated between 2 layers of polyethylene film. Film shall meet flame resistant standards of NFPA 701.

1.24.6 Amended Water

Amended water shall meet the requirements of ASTM D 1331.

1.24.7 Mastic Removing Solvent

Mastic removing solvent shall be nonflammable and shall not contain methylene chloride, glycol ether, or halogenated hydrocarbons. Solvents used onsite shall have a flash point greater than 60 degrees C.

1.24.8 Leak-tight Wrapping

Two layers of 0.15 mm minimum thick polyethylene sheet stock shall be used for the containment of removed asbestos-containing components or materials such as reactor vessels, large tanks, boilers, insulated pipe segments and other materials too large to be placed in disposal bags. Upon placement of the ACM component or material, each layer shall be individually leak-tight sealed with duct tape.

1.24.9 Viewing Inspection Window

Where feasible, a minimum of 1 clear, 3 mm thick, acrylic sheet, 450 by 610 mm , shall be installed as a viewing inspection window at eye level on a wall in each containment enclosure. The windows shall be sealed leak-tight with industrial grade duct tape.

1.24.10 Wetting Agents

Removal encapsulant (a penetrating encapsulant) shall be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant shall be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water. Performance requirements for penetrating encapsulants are specified in paragraph ENCAPSULANTS.

1.24.11 Strippable Coating

Strippable coating in aerosol cans shall be used to adhere to surfaces and to be removed cleanly by stripping, at the completion of work. This work shall only be done in well ventilated areas.

1.25 MISCELLANEOUS ITEMS

A sufficient quantity of other items, such as, but not limited to: scrapers, brushes, brooms, staple guns, tarpaulins, shovels, rubber squeegees, dust pans, other tools, scaffolding, staging, enclosed chutes, wooden ladders, lumber necessary for the construction of containments, UL approved temporary electrical equipment, material and cords, ground fault circuit interrupters, water hoses of sufficient length, fire extinguishers, first aid kits, portable toilets, logbooks, log forms, markers with indelible ink, spray paint in bright color to mark areas, project boundary fencing, etc., shall be provided.

## PART 2 PRODUCTS

### 2.1 ENCAPSULANTS

Encapsulants shall conform to USEPA requirements, shall contain no toxic or hazardous substances and no solvent and shall meet the following requirements:

ALL ENCAPSULANTS

| Requirement | Test Standard |
|---|---|
| Flame Spread - 25, Smoke Emission - 50 | ASTM E 84 |
| Combustion Toxicity Zero Mortality | Univ. of Pittsburgh Protocol |
| Life Expectancy, 20 yrs Accelerated Aging Test | ASTM C 732 |
| Permeability, Min. 23 ng per Pa-sec-square m | ASTM E 96 |

Additional Requirements for Bridging Encapsulant

| Requirement | Test Standard |
|---|---|
| Cohesion/Adhesion Test, 730 N/m | ASTM E 736 |
| Fire Resistance, Negligible affect on fire resistance rating over 3 hour test (Classified by UL for use over fibrous and cementitious sprayed fireproofing) | ASTM E 119 |
| Impact Resistance, Min. 4.7 N-m (Gardner Impact Test) | ASTM D 2794 |
| Flexibility, no rupture or cracking (Mandrel Bend Test) | ASTM D 522 |

Additional Requirements for Penetrating Encapsulant

| Requirement | Test Standard |
|---|---|
| Cohesion/Adhesion Test, 730 N/m | ASTM E 736 |
| Fire Resistance, Negligible affect on fire resistance rating over 3 hour test (Classified | ASTM E 119 |

ALL ENCAPSULANTS

| Requirement | Test Standard |
|---|---|
| by UL for use over fibrous and cementitious sprayed fireproofing) | |
| Impact Resistance, Min. 4.7 N-m (Gardner Impact Test) | ASTM D 2794 |
| Flexibility, no rupture or cracking (Mandrel Bend Test) | ASTM D 522 |

Additional Requirements for Lockdown Encapsulant

| Requirement | Test Standard |
|---|---|
| Fire Resistance, Negligible affect on fire resistance rating over 3 hour test (Tested with fireproofing over encapsulant applied directly to steel member) | ASTM E 119 |
| Bond Strength, 1.5 kN/m (Tests compatibility with cementitious and fibrous fireproofing) | ASTM E 736 |

## 2.2 ENCASEMENT PRODUCTS

Encasement shall consist of primary cellular polymer coat, polymer finish coat, and any other finish coat as approved by the Contracting Officer.

## 2.3 RECYCLABLE MATERIALS

The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

# PART 3 EXECUTION

## 3.1 GENERAL REQUIREMENTS

Asbestos abatement work tasks shall be performed as shown on the detailed plans and drawings, as summarized in paragraph DESCRIPTION OF WORK and including Table 1 and the Contractor's Accident Prevention Plan, Asbestos Hazard Abatement Plan, and the Activity Hazard Analyses. The Contractor shall use the engineering controls and work practices required in 29 CFR 1926, Section .1101(g) in all operations regardless of the levels of exposure. Personnel shall wear and utilize protective clothing and equipment as specified. The Contractor shall not permit eating, smoking, drinking, chewing or applying cosmetics in the regulated area. All hot work (burning, cutting, welding, etc.) shall be conducted under controlled conditions in conformance with 29 CFR 1926, Section .352, Fire Prevention. Personnel of other trades, not engaged in asbestos abatement activities, shall not be exposed at any time to airborne concentrations of asbestos unless all the administrative and personal protective provisions of the Contractor's Accident Prevention Plan are complied with. Power to the regulated area shall be locked-out and tagged in accordance with 29 CFR 1910, and temporary electrical service with ground fault circuit interrupters shall be provided as needed. Temporary electrical service shall be disconnected when necessary for wet removal. The Contractor shall stop abatement work in the regulated area immediately when the airborne total fiber concentration: (1) equals or exceeds 0.01 f/cc, or the pre-abatement concentration, whichever is greater, outside the regulated area; or (2) equals or exceeds 1.0 f/cc inside the regulated area. The Contractor shall correct the condition to the satisfaction of the Contracting Officer, including visual inspection and air sampling. Work shall resume only upon notification by the Contracting Officer. Corrective actions shall be documented.

## 3.2 PROTECTION OF ADJACENT WORK OR AREAS TO REMAIN

Asbestos abatement shall be performed without damage to or contamination of adjacent work or area. Where such work or area is damaged or contaminated, as verified by the Contracting Officer using visual inspection or sample analysis, it shall be restored to its original condition or decontaminated by the Contractor at no expense to the Government, as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, work shall stop in all effected areas immediately and the spill shall be cleaned. When satisfactory visual inspection and air sampling analysis results are obtained and have been evaluated by the Contractor's Designated IH and the Contracting Officer, work shall proceed.

## 3.3 OBJECTS

### 3.3.1 Removal of Mobile Objects

Mobile objects, furniture, and equipment will be removed from the area of work by the Government before asbestos abatement work begins.

### 3.3.2 Stationary Objects

Stationary objects, furniture, and equipment shall remain in place and shall be precleaned using HEPA vacuum followed by adequate wet wiping. Stationary objects and furnishings shall be covered with 2 layers of polyethylene and edges sealed with duct tape.

## 3.4 BUILDING VENTILATION SYSTEM AND CRITICAL BARRIERS

Building ventilating systems supplying air into or returning air out of a regulated area shall be shut down and isolated by lockable switch or other positive means in accordance with 29 CFR 1910, Section .147. Air-tight critical barriers shall be installed on building ventilating openings located inside the regulated area that supply or return air from the building ventilation system or serve to exhaust air from the building. The critical barriers shall consist of 2 layers of polyethylene. Edges to wall, ceiling and floor surfaces shall be sealed with industrial grade duct tape. Critical barriers shall be installed in accordance with applicable regulations..

## 3.5 PRECLEANING

Horizontal surfaces shall be cleaned by HEPA vacuum and adequately wet wiped prior to establishment of containment.

## 3.6 METHODS OF COMPLIANCE

### 3.6.1 Mandated Practices

The Contractor shall employ proper handling procedures in accordance with 29 CFR 1926 and 40 CFR 61, Subpart M, and the specified requirements. The specific abatement techniques and items identified shall be detailed in the Contractor's Asbestos Hazard Abatement Plan including, but not limited to, details of construction materials, equipment, and handling procedures. The Contractor shall use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

a. Vacuum cleaners equipped with HEPA filters to collect debris and dust containing ACM.

b. Wet methods or wetting agents to control employee exposures during asbestos handling, mixing, removal, cutting, application, and cleanup; except where it can be demonstrated that the use of wet methods is unfeasible due to, for example, the creation of electrical hazards, equipment malfunction, and in roofing.

c. Prompt clean-up and disposalin leak-tight containers of wastes and debris contaminated with asbestos.

d. Inspection and repair of polyethylene in work and high traffic areas.

e. Cleaning of equipment and surfaces of containers filled with ACM prior to removing them from the equipment room or area.

### 3.6.2 Control Methods

The Contractor shall use the following control methods to comply with the PELs:

a. Local exhaust ventilation equipped with HEPA filter dust collection systems;

b. Enclosure or isolation of processes producing asbestos dust;

c. Ventilation of the regulated area to move contaminated air away from the breathing zone of employees and toward a filtration or collection device equipped with a HEPA filter;

d. Use of other work practices and engineering controls;

e. Where the feasible engineering and work practice controls described above are not sufficient to reduce employee exposure to or below the PELs, the Contractor shall use them to reduce employee exposure to the lowest levels attainable by these controls and shall supplement them by the use of respiratory protection that complies with paragraph, RESPIRATORY PROTECTION PROGRAM.

3.6.3 Unacceptable Practices

The following work practices and engineering controls shall not be used for work related to asbestos or for work which disturbs ACM, regardless of measured levels of asbestos exposure or the results of initial exposure assessments:

a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

b. Compressed air used to remove asbestos, or materials containing asbestos, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

c. Dry sweeping, shoveling, or other dry clean-up of dust and debris containing ACM.

d. Employee rotation as a means of reducing employee exposure to asbestos.

3.6.4 Class II Work

In addition to the requirements of paragraphs Mandated Practices and Control Methods, the following engineering controls and work practices shall be used:

a. A Competent Person shall supervise the work.

b. For indoor work, critical barriers shall be placed over all openings to the regulated area.

c. Impermeable dropcloths shall be placed on surfaces beneath all removal activity.

3.6.5 Specific Control Methods for Class II Work

In addition to requirements of paragraph Class II Work, Class II work shall be performed using the following methods:

3.6.5.1 Vinyl and Asphalt Flooring Materials

When removing vinyl and asphalt flooring materials which contain ACM, the Contractor shall use the following practices as shown in RESPONSE ACTION DETAIL SHEET 56 60. Resilient sheeting shall be removed by adequately wet methods. Tiles shall be removed intact (if possible); wetting is not required when tiles are heated and removed intact. Flooring or its backing shall not be sanded. Scraping of residual adhesive and/or backing shall be performed using wet methods. Mechanical chipping is prohibited unless performed in a negative pressure enclosure. Dry sweeping is prohibited. The Contractor shall use vacuums equipped with HEPA filter, disposable dust bag, and metal floor tool (no brush) to clean floors.

3.6.6 Cleaning After Asbestos Removal

After completion of all asbestos removal work, surfaces from which ACM has been removed shall be wet wiped or sponged clean, or cleaned by some equivalent method to remove all visible residue. Run-off water shall be collected and filtered through a dual filtration system. A first filter shall be provided to remove fibers 20 micrometers and larger, and a final filter provided that removes fibers 5 micrometers and larger. After the gross amounts of asbestos have been removed from every surface, remaining visible accumulations of asbestos on floors shall be collected using plastic shovels, rubber squeegees, rubber dustpans, and HEPA vacuum cleaners as appropriate to maintain the integrity of the regulated area.

3.6.7 Class II Asbestos Work Response Action Detail Sheets

The following Class II Asbestos Work Response Action Detail Sheet is specified on Table 1 for each individual work task to be performed:

a. Vinyl or Vinyl Asbestos Tile Adhered to Concrete Floor System by Asbestos-Containing Adhesive: See Sheet 56

b. Vinyl or Vinyl Asbestos Tile Adhered to Wood Floor System by Asbestos Containing Adhesive: See Sheet 60

3.6.8 Sealing Contaminated Items Designated for Disposal

Contaminated architectural, mechanical, and electrical appurtenances such as Venetian blinds, full height partitions, carpeting, duct work, pipes and fittings, radiators, light fixtures, conduit panels, and other contaminated items designated for removal shall be coated with an asbestos lockdown encapsulant at the demolition site before being removed from the asbestos control area. These items shall be vacuumed prior to application of the lockdown encapsulant. The asbestos lockdown encapsulant shall be tinted a contrasting color and shall be spray applied by airless method. Thoroughness of sealing operation shall be visually gauged by the extent of colored coating on exposed surfaces.

3.7 FINAL CLEANING AND VISUAL INSPECTION

Upon completion of abatement, the regulated area shall be cleaned by collecting, packing, and storing all gross contamination. A final cleaning shall be performed using HEPA vacuum and wet cleaning of all exposed surfaces and objects in the regulated area.Upon completion of the cleaning, the Contractor shall conduct a visual pre-inspection of the cleaned area in preparation for a final inspection before final air clearance monitoring and recleaning, as necessary. Upon completion of the final cleaning, the Contractor and the Contracting Officer shall conduct a final visual inspection of the cleaned regulated area in accordance with ASTM E 1368 and document the results on the Final Cleaning and Visual Inspection as specified on the SET-UP DETAIL SHEET 19. If the Contracting Officer rejects the clean regulated area as not meeting final cleaning requirements, the Contractor shall reclean as necessary and have a follow-on inspection conducted with the Contracting Officer. Recleaning and follow-up reinspection shall be at the Contractor's expense.

## 3.8 LOCKDOWN

Prior to removal of plastic barriers and after clean-up of gross contamination and final visual inspection, a post removal (lockdown) encapsulant shall be spray applied to ceiling, walls, floors, and other surfaces in the regulated area.

## 3.9 EXPOSURE ASSESSMENT AND AIR MONITORING

### 3.9.1 General Requirements For Exposure

Exposure assessment, air monitoring and analysis of airborne concentration of asbestos fibers shall be performed in accordance with 29 CFR 1926, Section .1101, the Contractor's air monitoring plan, and as specified. Personal exposure air monitoring (collected at the breathing zone) that is representative of the exposure of each employee who is assigned to work within a regulated area shall be performed by the Contractor's Designated IH. Breathing zone samples shall be taken for at least 25 percent of the workers in each shift, or a minimum of 2, whichever is greater. Air monitoring results at the 95 percent confidence level shall be calculated as shown in Table 2 at the end of this section. The Contractor shall provide an onsite independent testing laboratory with qualified analysts and appropriate equipment to conduct sample analyses of air samples using the methods prescribed in 29 CFR 1926, Section .1101, to include NIOSH Pub No. 84-100 Method 7400. Preabatement and abatement environmental air monitoring shall be performed by the Contractor's Designated IH. Final clearance environmental air monitoring, shall be performed by the Contractor's Designated IH and Contracting Officer's IH. Environmental and final clearance air monitoring shall be performed using NIOSH Pub No. 84-100 Method 7400 (PCM) with optional confirmation of results by the EPA TEM Method specified in 40 CFR 763. For environmental and final clearance, air monitoring shall be conducted at a sufficient velocity and duration to establish the limit of detection of the method used at 0.005 f/cc. Confirmation of asbestos fiber concentrations (asbestos f/cc) from environmental and final clearance samples collected and analyzed by NIOSH Pub No. 84-100 Method 7400 (total f/cc) may be conducted using TEM in accordance with NIOSH Pub No. 84-100 Method 7402. When such confirmation is conducted, it shall be from the same sample filter used for the NIOSH Pub No. 84-100 Method 7400 PCM analysis. For all Contractor required environmental or final clearance air monitoring, confirmation of asbestos fiber concentrations, using NIOSH Pub No. 84-100 Method 7402, shall be at the Contractor's expense. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. Results of breathing zone samples shall be posted at the job site and made available to the Contracting Officer. The Contractor shall maintain a fiber concentration inside a regulated area less than or equal to 0.1 f/cc expressed as an 8 hour, time-weighted average (TWA) during the conduct of the asbestos abatement. If fiber concentration rises above 0.1 f/cc, work procedures shall be investigated with the Contracting Officer to determine the cause.

At the discretion of the Contracting Officer, fiber concentration may exceed 0.1 f/cc but shall not exceed 1.0 f/cc expressed as an 8-hour TWA. The Contractor's workers shall not be exposed to an airborne fiber concentration in excess of 1.0 f/cc, as averaged over a sampling period of 30 minutes. Should either an environmental concentration of 1.0 f/cc expressed as an 8-hour TWA or a personal excursion concentration of 1.0 f/cc expressed as a 30-minute sample occur inside a regulated work area, the Contractor shall stop work immediately, notify the Contracting Officer, and implement additional engineering controls and work practice controls to reduce airborne fiber levels below prescribed limits in the work area. Work shall not restart until authorized by the Contracting Officer.

3.9.2 Initial Exposure Assessment

The Contractor's Designated IH shall conduct an exposure assessment immediately before or at the initiation of an asbestos abatement operation to ascertain expected exposures during that operation. The assessment shall be completed in time to comply with the requirements which are triggered by exposure data or the lack of a negative exposure assessment, and to provide information necessary to assure that all control systems planned are appropriate for that operation. The assessment shall take into consideration both the monitoring results and all observations, information or calculations which indicate employee exposure to asbestos, including any previous monitoring conducted in the workplace, or of the operations of the Contractor which indicate the levels of airborne asbestos likely to be encountered on the job.

3.9.3 Negative Exposure Assessment

The Contractor shall provide a negative exposure assessment for the specific asbestos job which will be performed. The negative exposure assessment shall be provided within 5 days of the initiation of the project and conform to the following criteria:

a. Objective Data: Objective data demonstrating that the product or material containing asbestos minerals or the activity involving such product or material cannot release airborne fibers in concentrations exceeding the PEL-TWA and PEL-Excursion Limit under those work conditions having the greatest potential for releasing asbestos.

b. Prior Asbestos Jobs: Where the Contractor has monitored prior asbestos jobs for the PEL and the PEL-Excursion Limit within 12 months of the current job, the monitoring and analysis were performed in compliance with asbestos standard in effect; the data were obtained during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the Contractor's current operations; the operations were conducted by employees whose training and experience are no more extensive than that of employees performing the current job; and these data show that under the conditions prevailing and which will prevail in the current workplace, there is a high degree of certainty that the monitoring covered exposure from employee exposures will not exceed the PEL-TWA and PEL-Excursion Limit.

c. Initial Exposure Monitoring: The results of initial exposure monitoring of the current job, made from breathing zone air samples that are representative of the 8-hour PEL-TWA and 30-minute short-term exposures of each employee. The monitoring covered exposure from operations which are most likely during the performance of the entire asbestos job to result in exposures over the PELs.

3.9.4 Independent Environmental Monitoring

The Government has retained an independent air monitoring firm to perform final clearance air monitoring. The air monitoring contractor has been provided a copy of the contract that includes this abatement work. The abatement contractor will provide the air monitoring contractor with an up-to-date copy of the accepted Asbestos Hazard Abatement Plan, Accident Prevention Plan and pertinent detailed drawings. The air monitoring contractor is required to comply with the abatement contractor's safety and health requirements. The abatement contractor will coordinate all onsite activities with the air monitoring contractor, the COR, and other affected parties as directed by the COR. The abatement contractor will provide the air monitoring contractor with an up-to-date schedule of abatement contractor work activities. The air monitoring contractor will coordinate with the abatement contractor and the COR during the performance Government required air monitoring. The abatement contractor is responsible for performing exposure assessment and personal air monitoring of abatement contractor's work. The air monitoring contractor is responsible for performing these tasks for its employee.

3.9.5 Preabatement Environmental Air Monitoring

Preabatement environmental air monitoring shall be established 1 day prior to the masking and sealing operations for each regulated area to determine background concentrations before abatement work begins. As a minimum, preabatement air samples shall be collected using NIOSH Pub No. 84-100 Method 7400, PCM at these locations: outside the building; inside the building, but outside the regulated area perimeter; and inside each regulated work area. One sample shall be collected for every 185 square meters of floor space. At least 2 samples shall be collected outside the building: at the exhaust of the HEPA unit; and downwind from the abatement site. The PCM samples shall be analyzed within 24 hours; and if any result in fiber concentration greater than 0.01 f/cc, asbestos fiber concentration shall be confirmed using NIOSH Pub No. 84-100 Method 7402 (TEM).

3.9.6 Environmental Air Monitoring During Abatement

Until an exposure assessment is provided to the Contracting Officer, environmental air monitoring shall be conducted at locations and frequencies that will accurately characterize any evolving airborne asbestos fiber concentrations. The assessment shall demonstrate that the product or material containing asbestos minerals, or the abatement involving such product or material, cannot release airborne asbestos fibers in concentrations exceeding 0.01 f/cc as a TWA under those work conditions having the greatest potential for releasing asbestos. The monitoring shall be at least once per shift at locations including, but not limited to, close to the work inside a regulated area; preabatement sampling locations; outside entrances to a regulated area; close to glovebag operations; representative locations outside of the perimeter of a regulated area; inside clean room; and at the exhaust discharge point of local exhaust system ducted to the outside of a containment (if used). If the sampling outside regulated area shows airborne fiber levels have exceeded background or 0.01 f/cc, whichever is greater, work shall be stopped immediately, and the Contracting Officer notified. The condition causing the increase shall be corrected. Work shall not restart until authorized by the Contracting Officer.

3.9.7 Final Clearance Air Monitoring

Prior to conducting final clearance air monitoring, the Contractor and the Contracting Officer shall conduct a final visual inspection of the regulated area where asbestos abatement has been completed. Final clearance air monitoring shall not begin until acceptance of the Contractor's final cleaning by the Contracting Officer. The Contractor's Designated IH shall and The Contracting Officer's IH will conduct final clearance air monitoring using aggressive air sampling techniques as defined in EPA 560/5-85-024 or as otherwise required by federal or state requirements. The sampling and analytical method used will be NIOSH Pub No. 84-100Method 7400 (PCM) and Table 3 with confirmation of results by the EPA TEM Method specified at 40 CFR 763 and Table 4.

3.9.7.1 Final Clearance Requirements, NIOSH PCM Method

For PCM sampling and analysis using NIOSH Pub No. 84-100 Method 7400, the fiber concentration inside the abated regulated area, for each airborne sample, shall be less than 0.01 f/cc. The abatement inside the regulated area is considered complete when every PCM final clearance sample is below the clearance limit. If any sample result is greater than 0.01 total f/cc, the asbestos fiber concentration (asbestos f/cc) shall be confirmed from that same filter using EPA TEM Method specified in 40 CFR 763 Table 4 at Contractor's expense. If any confirmation sample result is greater than 0.01 asbestos f/cc, abatement is incomplete and cleaning shall be repeated. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria shall be done.

3.9.7.2 Final Clearance Requirements, EPA TEM Method

For EPA TEM sampling and analysis, using the EPA Method specified in 40 CFR 763, abatement inside the regulated area is considered complete when the arithmetic mean asbestos concentration of the 5 inside samples is less than or equal to 70 structures per square millimeter (70 S/mm). When the arithmetic mean is greater than 70 S/mm, the 3 blank samples shall be analyzed. If the 3 blank samples are greater than 70 S/mm, resampling shall be done. If less than 70 S/mm, the 5 outside samples shall be analyzed and a Z-test analysis performed. When the Z-test results are less than 1.65, the decontamination shall be considered complete. If the Z-test results are more than 1.65, the abatement is incomplete and cleaning shall be repeated. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria shall be done.

3.9.7.3 Air Clearance Failure

If clearance sampling results fail to meet the final clearance requirements, the Contractor shall pay all costs associated with the required recleaning, resampling, and analysis, until final clearance requirements are met.

3.9.8 Air-Monitoring Results and Documentation

Air sample fiber counting shall be completed and results provided within 24 hours (breathing zone samples), and 48 hours (environmental/clearance monitoring) after completion of a sampling period. The Contracting Officer shall be notified immediately of any airborne levels of asbestos fibers in excess of established requirements. Written sampling results shall be provided within 5 working days of the date of collection. The written results shall be signed by testing laboratory analyst, testing laboratory principal and the Contractor's Designated IH. The air sampling results shall be documented on a Contractor's daily air monitoring log. The daily air monitoring log shall contain the following information for each sample:

a. Sampling and analytical method used;

b. Date sample collected;

c. Sample number;

d. Sample type: BZ = Breathing Zone (Personal), P = Preabatement, E = Environmental, C = Abatement Clearance;

e. Location/activity/name where sample collected;

f. Sampling pump manufacturer, model and serial number, beginning flow rate, end flow rate, average flow rate (L/min);

g. Calibration date, time, method, location, name of calibrator, signature;

h. Sample period (start time, stop time, elapsed time (minutes);

i. Total air volume sampled (liters);

j. Sample results (f/cc and S/mm square) if EPA methods are required for final clearance;

k. Laboratory name, location, analytical method, analyst, confidence level. In addition, the printed name and a signature and date block for the Industrial Hygienist who conducted the sampling and for the Industrial Hygienist who reviewed the daily air monitoring log verifying the accuracy of the information.

3.10 CLEARANCE CERTIFICATION

When asbestos abatement is complete, ACM waste is removed from the regulated areas, and final clean-up is completed, the Contracting Officer will certify the areas as safe before allowing the warning signs and boundary warning tape to be removed. After final clean-up and acceptable airborne concentrations are attained, but before the HEPA unit is turned off and the containment removed, the Contractor shall remove all pre-filters on the building HVAC system and provide new pre-filters. The Contractor shall dispose of such filters as asbestos contaminated materials. HVAC, mechanical, and electrical systems shall be re-established in proper working order. The Contractor and the Contracting Officer shall visually inspect all surfaces within the containment for residual material or accumulated debris. The Contractor shall reclean all areas showing dust or residual materials. The Contracting Officer will certify in writing that the area is safe before unrestricted entry is permitted. The Government will have the option to perform monitoring to certify the areas are safe before entry is permitted.

## 3.11 CLEANUP AND DISPOSAL

### 3.11.1 Title to ACM Materials

ACM material resulting from abatement work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified and in accordance with applicable federal, state and local regulations.

### 3.11.2 Collection and Disposal of Asbestos

All ACM waste shall be collected and including contaminated wastewater filters, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing, shall be collected and placed in leak-tight containers such as double plastic bags ; sealed double wrapped polyethylene sheet ; sealed fiberboard boxes ; or other approved containers. Waste within the containers shall be wetted in case the container is breeched. Asbestos-containing waste shall be disposed of at an EPA, state and local approved asbestos landfill. For temporary storage, sealed impermeable containers shall be stored in an asbestos waste load-out unit or in a storage/transportation conveyance (i.e., dumpster, roll-off waste boxes, etc.) in a manner acceptable to and in an area assigned by the Contracting Officer. Procedure for hauling and disposal shall comply with 40 CFR 61, Subpart M, state, regional, and local standards.

### 3.11.3 Scale Weight Measurement

Scales used for measurement shall be public scales. Weighing shall be at a point nearest the work at which a public scale is available. Scales shall be standard truck scales of the beam type; scales shall be equipped with the type registering beam and an "over and under" indicator; and shall be capable of accommodating the entire vehicle. Scales shall be tested, approved and sealed by an inspector of the State of Texas. Scales shall be calibrated and resealed as often as necessary and at least once every three months to ensure continuous accuracy. Vehicles used for hauling ACM shall be weighed empty daily at such time as directed and each vehicle shall bear a plainly legible identification mark.

3.11.4 Weigh Bill and Delivery Tickets

Copies of weigh bills and delivery tickets shall be submitted to the Contracting Officer during the progress of the work. The Contractor shall furnish the Contracting Officer scale tickets for each load of ACM weighed and certified. These tickets shall include tare weight; identification mark for each vehicle weighed; and date, time and location of loading and unloading. Tickets shall be furnished at the point and time individual trucks arrive at the worksite. A master log of all vehicle loading shall be furnished for each day of loading operations. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified weigh bills and/or certified tickets and manifests of all ACM actually disposed by the Contractor for this contract.

3.11.5 Asbestos Waste Shipment Record

The Contractor shall complete and provide the Contracting Officer final completed copies of the Waste Shipment Record for all shipments of waste material as specified in 40 CFR 61, Subpart M and other required state waste manifest shipment records, within 3 days of delivery to the landfill. Each Waste Shipment Record shall be signed and dated by the Contracting Officer, the waste transporter and disposal facility operator.

TABLE 1

INDIVIDUAL WORK TASK DATA ELEMENTS

Sheet___1__ of ___1__

There is a separate data sheet for each individual work task.

1. WORK TASK DESIGNATION NUMBER __1_____
2. LOCATION OF WORK TASK__Building 4302, Storage Room and Closet ________________________________________

   ________________________________________________________________
3. BRIEF DESCRIPTION OF MATERIAL TO BE ABATED:____________________
   _____305 mm x 305 mm Floor Tile and Mastic _____

   a. Type of Asbestos ___Chrysotile__________________________
   b. Percent asbestos content ______3______________%

4. ABATEMENT TECHNIQUE TO BE USED__Gross Removal with Enclosure _______________________________
5. OSHA ASBESTOS CLASS DESIGNATION FOR WORK TASK__II________________
6. EPA NESHAP FRIABILITY DESIGNATION FOR WORK TASK
   Friable _____ Non-friable Category I __X___
   Non-friable Category II_____
7. FORM _____ and CONDITION OF ACM: GOOD_____ FAIR__X___ POOR_____
8. QUANTITY: METERS__________________, SQUARE METERS____13.94__________

8a. QUANTITY: LINEAR FT._______________, SQUARE FT.____150___________

9. RESPONSE ACTION DETAIL SHEET NUMBER FOR WORK TASK______________
10. SET-UP DETAIL SHEET NUMBERS
    FOR WORK TASK __56________, ____60______, __________, ____, __________, __________, __________, __________.

NOTES:

(1) Numeric sequence of individual work tasks (1,2,3,4, etc.) for each regulated area. Each category of EPA friability/OSHA class has a separate task.

(2) Specific location of work (building, floor, area, e.g., Building 1421, 2nd Floor, Rm 201)

(3) A description of material to be abated (example: horizontal pipe, cement wall panels, tile, stucco, etc.) type of asbestos (chrysotile, amosite, crocidolite, etc.); and % asbestos content.

(4) Technique to be used: Removal = REM; Encapsulation = ENCAP; Encasement = ENCAS; Enclosure = ENCL; Repair = REP.

(5) Class designation: Class I, II, III, or IV (OSHA designation).

(6) Friability of materials: Check the applicable EPA NESHAP friability designation.

(7) Form: Interior or Exterior Architectural = IA or EA; Mechanical/Electrical = ME.
    Condition: Good = G; Fair = F; Poor = P.

(8) Quantity of ACM for each work task in meters or square meters.

(8a) Quantity of ACM for each work task in linear feet or square feet.

(9) Response Action Detail Sheet specifies the material to be abated and the methods to be used. There is only one Response Action

TABLE 1

INDIVIDUAL WORK TASK DATA ELEMENTS

Detail Sheet for each abatement task.

(10) Set-up Detail Sheets indicate containment and control methods used in support of the response action (referenced in the selected Response Action Detail Sheet).

TABLE 2

FORMULA FOR CALCULATION OF THE 95 PERCENT CONFIDENCE LEVEL
(Reference: NIOSH 7400)

---

Fibers/cc(01.95 percent CL) = X + [(X) * (1.645) * (CV)]

Where: X = ((E)(AC))/((V)(1000))

E = ((F/Nf) - (B/Nb))/Af

CV = The precision value; 0.45 shall be used unless the analytical laboratory provides the Contracting Officer with documentation (Round Robin Program participation and results) that the laboratory's precision is better.

AC = Effective collection area of the filter in square millimeters

V = Air volume sampled in liters

E = Fiber density on the filter in fibers per square millimeter

F/Nf = Total fiber count per graticule field

B/Nb = Mean field blank count per graticule field

Af = Graticule field area in square millimeters

TWA = C1/T1 + C2/T2 = Cn/Tn

Where: C = Concentration of contaminant

T = Time sampled.

TABLE 3

NI0SH METHOD 7400

PCM ENVIRONMENTAL AIR SAMPLING PROTOCOL (NON-PERSONAL)

| Sample Location | Minimum No. of Samples | Filter Pore Size (Note 1) | Min. Vol. (Note 2) (Liters) | Sampling Rate (liters/min.) |
|---|---|---|---|---|
| Inside Abatement Area | 0.5/140 Square Meters (Notes 3 & 4) | 0.45 microns | 3850 | 2-16 |
| Each Room in 1 Abatement Area Less than 140 Square meters | | 0.45 microns | 3850 | 2-16 |
| Field Blank | 2 | 0.45 microns | 0 | 0 |
| Laboratory Blank | 1 | 0.45 microns | 0 | 0 |

Notes:

1. Type of filter is Mixed Cellulose Ester.

2. Ensure detection limit for PCM analysis is established at 0.005 fibers/cc.

3. One sample shall be added for each additional 140 square meters. (The corresponding I-P units are 5/1500 square feet).

4. A minimum of 5 samples are to be taken per abatement area, plus 2 field blanks.

TABLE 4

EPA AHERA METHOD: TEM AIR SAMPLING PROTOCOL

| Location Sampled | Minimum No. of Samples | Filter Pore Size | Min. Vol. (Liters) | Sampling Rate (liters/min.) |
|---|---|---|---|---|
| Inside Abatement Area | 5 | 0.45 microns | 1500 | 2-16 |
| Outside Abatement Area | 5 | 0.45 microns | 1500 | 2-16 |
| Field Blank | 2 | 0.45 microns | 0 | 0 |
| Laboratory Blank | 1 | 0.45 microns | 0 | 0 |

Notes:

1. Type of filter is Mixed Cellulose Ester.

2. The detection limit for TEM analysis is 70 structures/square mm.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

PROJECT NAME _________________________ CONTRACT NO. ______________________
PROJECT ADDRESS __________________________________________________________
CONTRACTOR FIRM NAME _____________________________________________________
EMPLOYEE'S NAME _________________________,_______________,______,
(Print) (Last) (First) (MI)

Social Security Number: _______-_______-________,

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH TYPES OF LUNG DISEASE AND CANCER. IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NONSMOKING PUBLIC.

Your employer's contract for the above project requires that you be provided and you complete formal asbestos training specific to the type of work you will perform and project specific training; that you be supplied with proper personal protective equipment including a respirator, that you be trained in its use; and that you receive a medical examination to evaluate your physical capacity to perform your assigned work tasks, under the environmental conditions expected, while wearing the required personal protective equipment. These things are to be done at no cost to you. By signing this certification, you are acknowledging that your employer has met these obligations to you. The Contractor's Designated Industrial Hygienist will check the block(s) for the type of formal training you have completed. Review the checked blocks prior to signing this certification.

FORMAL TRAINING:
_____ a. For Competent Persons and Supervisors: I have completed EPA's Model Accreditation Program (MAP) training course, "Contractor/Supervisor", that meets this State's requirements.

b. For Workers:
_____ (1) For OSHA Class I work: I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
_____ (2) For OSHA Class II work (where there will be abatement of more than one type of Class II materials, i.e., roofing, siding, floor tile, etc.): I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
(3) For OSHA Class II work (there will only be abatement of one type of Class II material):
_____ (a) I have completed an 8-hour training class on the elements of 29 CFR 1926, Section .1101(k)(9)(viii), in addition to the specific work practices and engineering controls of 29 CFR 1926, Section .1101(g) and hands-on training.
_____ (b) I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
_____ (4) For OSHA Class III work: I have completed at least a 16-hour course consistent with EPA requirements for training of local education agency maintenance and custodial staff at 40 CFR 763, Section .92(a)(2) and

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

the elements of 29 CFR 1926, Section .1101(k)(9)(viii), in addition to the specific work practices and engineering controls at 29 CFR 1926, Section .1101, and hands-on training.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

_____ (5) For OSHA Class IV work: I have completed at least a 2-hr course consistent with EPA requirements for training of local education agency maintenance and custodial staff at 40 CFR 763, (a)(1), and the elements of 29 CFR 1926, Section .1101(k)(9)(viii), in addition to the specific work practices and engineering controls at 29 CFR 1926, Section .1101(g) and hands-on training.

_____ c. Workers, Supervisors and the Designated Competent Person: I have completed annual refresher training as required by EPA's MAP that meets this State's requirements.

PROJECT SPECIFIC TRAINING:
_____ I have been provided and have completed the project specific training required by this Contract. My employer's Designated Industrial Hygienist and Designated Competent Person conducted the training.

RESPIRATORY PROTECTION:
_____ I have been trained in accordance with the criteria in the Contractor's Respiratory Protection program. I have been trained in the dangers of handling and breathing asbestos dust and in the proper work procedures and use and limitations of the respirator(s) I will wear. I have been trained in and will abide by the facial hair and contact lens use policy of my employer.

RESPIRATOR FIT-TEST TRAINING:
_____ I have been trained in the proper selection, fit, use, care, cleaning,maintenance, and storage of the respirator(s) that I will wear. I have been fit-tested in accordance with the criteria in the Contractor's Respiratory Program and have received a satisfactory fit. I have been assigned my individual respirator. I have been taught how to properly perform positive and negative pressure fit-check upon donning negative pressure respirators each time.

MEDICAL EXAMINATION:
_____ I have had a medical examination within the last twelve months which was paid for by my employer. The examination included: health history, pulmonary function tests, and may have included an evaluation of a chest x-ray. A physician made a determination regarding my physical capacity to perform work tasks on the project while wearing personal protective equipment including a respirator. I was personally provided a copy and informed of the results of that examination. My employer's Industrial Hygienist evaluated the medical certification provided by the physician and checked the appropriate blank below. The physician determined that there:

_____ were no limitations to performing the required work tasks.
_____ were identified physical limitations to performing the required work tasks.

Date of the medical examination __________________

Employee Signature ______________________________________ date ___________

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

Contractor's Industrial
Hygienist Signature ____________________________________ date ___________

-- End of Section --

# SECTION 13284

## REMOVAL, RECYCLING AND DISPOSAL OF REGULATED MATERIALS
**10/2000**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

CODE OF FEDERAL REGULATIONS (CFR)

| | |
|---|---|
| 29 CFR 1910 | Occupational Safety and Health Standards |
| 29 CFR 1926 | Safety and Health Regulations for Construction |
| 40 CFR 82 | Protection of Stratospheric Ozone |
| 40 CFR 261 | Identification and Listing of Hazardous Waste |
| 40 CFR 262 | Standards Applicable to Generators of Hazardous Waste |
| 40 CFR 263 | Standards Applicable to Transporters of Hazardous Waste |
| 40 CFR 264 | Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities |
| 40 CFR 268 | Land Disposal Restrictions |
| 40 CFR 270 | EPA Administered Permit Programs: The Hazardous Waste Permit Program |
| 40 CFR 273 | Standards for Universal Waste Management |
| 40 CFR 761 | Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Use Prohibitions |
| 49 CFR 171 | General Information, Regulations and Definitions |
| 49 CFR 173 | Shippers - General Requirements for |

| | |
|---|---|
| | Shipments and Packagings |
| 49 CFR 178 | Specifications for Packagings |

TEXAS ADMINISTRATIVE CODE (TAC)

| | |
|---|---|
| TAC 335.91 - 335.94 | Standards Applicable to Transporters of Hazardous Waste |

U.S. ARMY CORPS OF ENGINEERS (COE)

| | |
|---|---|
| COE EM 385-1-1 | (Current Edition) Safety and Health Requirements Manual |

## 1.2 DEFINITIONS

### 1.2.1 Regulated Materials

Regulated materials are arsenic (As), cadmium (Cd), cesium, chlordane, creosote, ethylene glycol, lead (Pb), mercury (Hg), oil and grease, ozone depleting chemicals (ODC), polychlorinated biphenyls (PCB), trichlorobenzene (TCB), diethylhexyl phthalate (DEPH), and tritium.

### 1.2.2 Arsenic

A solid and poisonous element that is commonly metallic, steel-gray, crystalline, and brittle.  A poisonous trioxide of arsenic is used especially as an insecticide or weed killer.  Typically, wood utility poles are treated with arsenic trioxide.

### 1.2.3 Ballast

A ballast is a device used to give starting voltage and/or stabilizing current to a fluorescent light tube.  Ballast is a metal case filled with a solid or semisolid asphalt/tar substance that contain a capacitor.  The capacitor may contain the following regulated materials: PCB, TCB or DEPH.

PCB was prohibited 1979 per 40 CFR 761.  Approximately half of the ballasts made before 1979 contained PCB.  "No PCBs" labels have been used to identify ballasts without PCB since 1 July 1978.  Therefore all ballasts without "No PCBs" labels, with labels of fabrication on or before 1979 and no known date of fabrication are assumed as PCB ballasts.  PCB-ballasts are regulated and disposal at a landfill is prohibited.

Ballasts from 4-foot lighting fixtures made before 1985 and from all other sizes of fixtures made before 1991 contained wet capacitors.  The replacement dielectric fluid for PCBs in these wet capacitors is mineral oil and solvents.  The hazardous solvents are typically TCB or DEPH. Unless the non-PCB ballasts are made after 1992, they are presumed to contain TCB or DEPH and shall be recycled at a permitted facility.

### 1.2.4 Cadmium

A bluish, white, malleable, ductile, toxic, bivalent, and metallic element.

It is especially used in protective plating, bearing metals, and electrodes for batteries.

1.2.5 Cesium

A silver white soft ductile element of the alkali metal that is the most electropositive element known and is especially used in photoelectric cells that is typically in smoke detector. Cesium ignites spontaneously in moist air; causes burns in contact with skin; may explode in contact with sulphur or phosphorus; reacts violently with oxidizing materials. Cesium 137 is a radioactive poison.

1.2.6 Chlordane

It was typically used for treatment of termites in soil around the building foundation and perimeter of structure. Sampling and testing are required for soil disposal.

1.2.7 Creosote

A brownish oily liquid, consisting chiefly of aromatic hydrocarbons. It is obtained by distillation of coal tar and used especially as a wood preservative (i.e. wood utility poles).

1.2.8 Emergency Lights

The emergency lights are operated by a back-up power source such as a battery. Mercury, cadmium, and lead are typically used in batteries.

1.2.9 Fluorescent Light Tube

A light bulb (or tube) of a fluorescent lighting fixture.

1.2.10 Lead

A heavy, soft, malleable, ductile, plastic but inelastic, bluish white, and metallic element. It is found mostly in combination and used especially in pipes, cable sheaths, batteries, solder, and shield against radioactivity.

1.2.11 Lighting Fixture

A unit containing a fluorescent light tube, light reflector, casing and ballast.

1.2.12 Mercury (Hg)

Mercury is a metal that is liquid at room temperature with a small vapor pressure. Mercury-containing items addressed in this specification are thermostats, fluorescent light tubes, and rechargeable battery.

1.2.13 Mercury Bulb Thermostat

A temperature control device containing a mercury ampule attached to a bimetallic sensing element.

1.2.14 Ozone Depleting Chemicals (ODC)

ODC include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halon, tetra (and tri) chloroethane, carbon tetrachloride and all isomers of methyl chloroform. A complete list of ODC are in40 CFR 82 Subpart A, Appendixes A and B. Items potentially containing ODC's are refrigeration equipment for HVAC systems, freezers, refrigerators, drinking fountains, ice machines, beverage and refrigerated food dispensers, halon fire extinguishers, and biomedical equipment.

1.2.15 Polychlorinated Biphenyls (PCBs)

PCB are defined in 40 CFR 761. They are oily in pure form. PCBs can enter the body through lungs, gastrointestinal tract, skin, can circulate through throughout the bosy, and can be stored in the fatty tissue. Available animal studies indicate an oncogenic potential. PCBs can cause adverse reproductive effects and developmental toxicity in humans. Items containing PCBs in this specification are ballasts and transformers (see definition of Ballast below).

1.2.16 Retorting Mercury

The retorting of mercury is a process whereby mercury is distilled from other materials by using heat. During the fluorescent light tube recycling process, mercury is retorting from phosphor powder that coats the inside of the glass tube.

1.2.17 Transformer

A device employing the principle of mutual induction to convert variations of current in a primary circuit into variations of voltage and current in a secondary circuit. It contains PCB, TCB and/or DEPH. It is pole-mounted or pad-mounted.

1.2.18 Tritium

It is a low radioactive gas, radioactive isotope of hydrogen with atoms of three times the mass of ordinary light hydrogen atoms. It has very low radiotoxicity and is typically used in luminous instrument dials such as lighted exit signs.

1.2.19 Utility Pole

It is typically used for mounting power cable, panel, lighting, control switch, or electrical device such as transformers. An exterior wood pole is typically preserved by pressure treatment with application of arsenic trioxide or creosote.

1.2.20 {AM#0001}DELETED

1.2.21 {AM#0001}DELETED

## 1.3 DESCRIPTION OF WORK

Prior to the start of demolition work, all items containing regulated materials shall be removed from the buildings. They shall be salvaged and recycled to the maximum extent possible or incinerated. Final disposal of regulated materials in a landfill shall be in accordance with applicable Federal, state, and local regulatory agencies, and when all means of recycling and reuse are exhausted.

## 1.4 CONTRACTOR'S QUALIFICATIONS

The Contractor and subcontractors shall have at least 2 years experience with battery, thermostats, delisted pesticides and be familiar with Universal Waste Rules in accordance with 40 CFR 273 and Mercury-Containing and Rechargeable Battery Recycling Act, Public Law 104-142, effective since May 13, 1996. The Contractor and subcontractors shall have at least 2 years experience with PCB-containing items and familiar with 40 CFR 761. The Contractor and subcontractors shall have at least at least 2 years experience in purging and reclaiming ODC and certified in accordance with 40 CFR 82. They shall also be familiar with other applicable Federal, state and local regulations for work to be performed in this specification.

## 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's Qualifications; G, RE.

Documentation of work experience in removal, recycling and/or disposal of items containing regulated material in accordance with paragraph, Contractor's Qualification.

ODC Recovery and Recycling Equipment's Certifications.

A copy of each ODC recovery and recycling equipment's certification in accordance with 40 CFR 82.158. A witten agreement of the fluorescent light tubes recycling facility to transport the packaged fluorecent light tubes.

A copy of certification from each technician reclaiming ODC in accordance with 40 CFR 82.161 and 40 CFR 82.164.

Licenses and Permits; G, RE.

A copy of the recycling/destruction facility license for handling, treatment and/or destruction of ballasts containing PCB, TCB and/or DEPH.

A copy of the RCRA Part B permit for the facility that is retorting mercury on site.

Proof of state registration or a copy of permit for pumping, hauling and transporting hazardous waste in accordance with TAC 335.91 - 335.94, and EPA permit per 40 CFR 263 if transporting to other state.

Proof of state registration to pump, transport or recycle grease trap sludge.

Notification of Recycling Activity;G, RE.

Contractor shall require to notify TNRCC 90 days prior to recycling activity with the form TNRCC-0525, "Generator Notification Form for Recycling Hazardous or Industrial Waste".

Plans.

A written Spill Prevention Plan shall be prepared in accordance with paragraph, SPILLS AND SAFETY of this section shall be submitted at least 30 days before start of work.

Environmental Pollution Insurance; G, RE.

A copy of the current environmental pollution liability insurance policy from the Contractor (subcontractors) and the recycling and/or destruction facilities.

SD-11 Closeout Submittals

Closure Report; G, RE.

A report in accordance with paragraph, CLOSURE REPORT shall be prepared and submitted in 10 working days or prior to final payment after completion of work specified in this section.

Recycling Activity Delivery Receipt.

The Contractor shall submit to the Contracting Officer a delivery receipt verifying recycling of these items to the Contracting Officer. Contractor shall be responsible to manifest in accordance with 40 CFR 261 and 761. Transportation shall be in accordance with 49 CFR 173 and 178.

## 1.6 WASTE MINIMIZATION, SALVAGE AND RECLAMATION

The Contractor shall segregate wastes to salvage and reclaim all items to their maximum extent and practice waste minimization. The Contractor shall not dispose of any item in its entirety to the landfill or by incineration. Regulated materials shall be manifested in accordance with 40 CFR 262, unless exemption is justified.

## 1.7 VERIFICATION OF REGULATED MATERIALS

Prior to initiation of work in this section, the Contractor shall field verify the actual locations, quantities and categories of items containing regulated materials. The Contractor shall notify the Contracting Officer of any discrepancies or conflicts before performing work.

## 1.8 REMOVAL, HANDLING AND PACKAGING

Removing, handling, and packaging shall be in accordance with COE EM 385-1-1.

### 1.8.1 Ballasts

The Contractor shall remove all ballasts from the lighting fixtures and place them into containers for shipping in accordance with 49 CFR 178. Leaking ballasts shall be placed in containers with absorbent material such as vermiculite or other suitable fire-retardant materials. Containers shall have affixed labels "Leaking PCB Ballasts" (NOTE: delete the inapplicable items). Intact ballasts shall be packed and labeled as "PCB Ballasts" . A typical container shall not hold more than 220 ballasts or the total weight of each container shall not exceed 400 kilograms (or 882 pounds). PCB ballast shall be managed in accordance with 40 CFR 761. These containers shall be transported to a permitted facility for incineration or destruction.

### 1.8.2 Lighted Exit Signs, Smoke Detectors, Emergency lights and Rechargeable Batteries

The Contractor shall field verify locations of these items. They shall be carefully removed and securely packed in separate labeled containers. The container voids shall be filled with vermiculite or other suitable fire-retardant materials. Shipping labels "Used Lighted Exit Signs Contain Tritium (Potential Hazard: Low Radiotoxicity)" and "Smoke Detectors Contain Cesium (Potential Hazard: Fire and Explosion Risk)" shall be affixed on containers with the intact components. Emergency lights with used batteries shall be placed in separate container labeled as "Emergency Lights with Used Batteries (Potential Hazard: lead, cadmium, mercury)". Other rechargeable batteries shall be placed in a separate container labeled as "Used Batteries (Potential Hazard: lead, cadmium, mercury)". The containers shall be vented and voids shall be filled with vermiculite or other suitable fire-retardant materials. The Contractor shall contact the DRMO to verify operating procedures for turning in items prior to removal of these items from the building structure and filling in the tracking document for final disposition.

### 1.8.3 Fluorescent Light Tubes and Lighting Fixtures

The Contractor shall remove the intact fluorescent light tubes from the lighting fixtures and place in the same boxes that held the replacement light tubes or other similar size containers that have box spacers to prevent breakage. Broken tubes shall be placed in containers in accordance with 49 CFR 178 and labeled as "Broken Fluorescent Light Tubes with Mercury". The containers with broken light tubes shall be manifested for transport and disposal in accordance with 40 CFR 262, 40 CFR 263, and 40

CFR 264. Fluorescent light tubes shall be transported by the recycling facility. The Contractor shall obtain written agreement from the recycling facility to transport the packaged light tubes. Metallic components of the lighting fixtures shall be recycled as scrap metal with other metallic components of the building structure. Plastic components of the lighting fixtures shall be segregated and recycled.

1.8.4 Mercury Bulb Thermostats

The Contractor shall remove and handle mercury bulb thermostats in accordance with 40 CFR 273. Leaking or broken ones shall be placed in a container with absorbent such as vermiculite and labeled as " Broken Mercury Bulb Thermostats". Intact bulb thermostats shall be packed and labeled as "Intact Mercury Bulb Thermostats." They shall be manifested for transportation and disposal in accordance with 40 CFR 262, 40 CFR 263, and 40 CFR 264.

1.8.5 ODC Units

The Contractor shall purge the units and handle ODC in accordance with 40 CFR 82 Subpart F prior to removal from existing locations. The salvaged refrigerant shall {AM#0001} be turned over to the Governement.

1.8.6 {AM#0001}DELETED

1.8.7 Transformers

The Contractor shall verify the locations of transformers as shown on the electrical utility layout or demolition plans and obtain data plates information for the transformers to be removed. The Contractor shall coordinate with the Base Civil Engineering or agency or POC as directed by the Contracting Officer that has access to the analytical data base of the transformers and obtain data plates information of the transformers to be removed. The Contractor shall perform sampling and analyses for PCB when no analytical results are available. Disconnection of electrical services shall be approved by [the Contracting Officer. The Contractor shall prepare government Form 1340 and list transformers identification numbers, types, sizes, and attach PCB test results from a currently licensed analytical laboratory (independent of the Contractor). A copy of Form 1340 shall be submitted to DOE and the Contracting Officer to schedule for pre-inspection. The Contractor shall remove and transport the transformers to a staging area approved by the Contracting Officer. In accordance with 40 CFR 761.20, The Contractor shall provide containment at the staging area to prevent storm water pollution. The Contractor shall prepare manifests (EPA Form 8700-22)for both PCB contaminated transformers (with PCB levels greater than 50 parts per millions (ppm) but less than 500 ppm) and PCB transformers (with PCB levels equal to or greater than 500 ppm). After approval of pre-inspection, the Contractor shall haul all transformers with Form 1340s to a designated location for final removal by DRMO. The Contractor shall provide shipping description (which consists of RQ designation, shipping name, hazard class, UN identification number, packing group, amd supplemental information) in accordance with 49 CFR 173.

1.8.8 Utility Poles

The Contractor shall verify locations and sizes of wood poles as shown on the electrical utility layout or demolition plans. The Contractor shall coordinate with the agency or POC as directed by the Contracting Officer to verify those used utility poles to be removed in this project. Utility poles shall be salvaged to the maximum extent possible by the Contractor. However, if they are disposed as waste material, the disposal facility receiving those wood poles shall have permit or written authorization by the Texas Natural Resource Conservation Commission (TNRCC) to receive wood poles which are typically contaminated with arsenic and/or creosote.

1.8.9 {AM#0001}DELETED

1.8.10 {AM#0001}DELETED

## 1.9 LABELING AND RECORD KEEPING

Labeling and record keeping of regulated materials to be salvaged, recycled, incinerated or placed in a landfill shall be in accordance with 40 CFR 262, 40 CFR 263, 40 CFR 264, and all other applicable Federal, State and local regulations. Bill of lading shall be prepared for each item to be shipped to recycling and/or destruction. Information shall include initial date of storage, generator's name and address, destination address and telephone number and the shipping weight.

## 1.10 SPILLS AND SAFETY

The Contractor shall prepare, maintain and implement a Spill Prevention Plan. The plan shall establish policies and procedures to prevent spills, minimize spill impact on its surroundings and methods to cleanup. The plan shall encompass all activities including at the site, transportation to recycling and/or destruction facilities. It shall address all the safety and health concerns in accordance with 29 CFR 1926 in event of a spill. It shall address clean-up requirements in accordance with 29 CFR 1910.120 paragraphs (b) through (o). Clean-up personnel shall meet the training requirements of 29 CFR 1910.38 (a); 1910.134; and 1910.1200. As a minimum, the following items shall be addressed in the plan: cleanup of spill by the Contractor; verification and approval of final clearance by the Contracting Officer; personal protective equipment (PPE) and decontamination procedures; equipment and material required for cleanup; reporting required to notify state, local, and the Contracting Officer verbally and in writing. The plan shall be kept on-site. Spills of one pound or more of PCBs (typically from 16 or more ballasts) shall be reported within 24 hours to National Response Center (1-800-424-8802), the Contracting Officer and cleaned up immediately. The Contractor shall assume full responsibility for compliance with all Federal, state, and local regulations for workers protection, work practices, site safety, transportation and disposal.

## 1.11 STORAGE

A temporary storage area shall be provided by the Contractor and approved by the Contracting Officer. Storage time limits are 30 days for ballasts containing PCBss (40 CFR 761) and 1 year for thermostats containing Hg (40

CFR 273). All regulated materials must be removed from the site before final acceptance of this project by the Government.

## 1.12 TRANSPORTATION

Items containing regulated materials shall be transported by a licensed, hazardous waste hauler. The Spill Prevention Plan shall be enforced by the Contractor to prevent spillage in accordance with 49 CFR 171 and 40 CFR 173. The hauler shall not store regulated materials longer than 10 days in accordance with 40 CFR 263 and 40 CFR 273. Vehicle loading, vehicle placarding, waste tracking, notification and record keeping shall be in accordance with all applicable Federal, State and local regulations.

## 1.13 RECYCLING/DESTRUCTION FACILITY

The Contractor shall use EPA permitted recycling, destruction facility in accordance with 40 CFR 261, 40 CFR 268 and 40 CFR 270 and/or state permitted or registered facility which holds current environmental pollution liability insurance coverage.

## 1.14 POTENTIAL BUYERS OF RECYCLED MATERIALS

Contractor shall use www.recycletexasonline.org to find potential buyer to recycle the PCB or wet-type (TCB and/or DEPH) ballasts or transformers.

The receiver of the PCB or wet-type (TCB or DEPH) ballasts or transformers shall have a RCRA Part B permit.

## 1.15 CLOSURE REPORT

The report shall contain: (1) A signed cover letter certifying completion of work described herein, (2) A signed Statement of Compliance, appended herein, (3) A brief narrative of worker protection and waste removal, segregation, packaging, transportation, and ultimate method of disposal (i.e. recycled/reuse, incinerated, landfill, etc.), (4) A description of accidents, ruptures, leaks, subsequent response procedures and cleanup, and (5) A copy of final disposition document of each item including at least the following: notification, signed manifest of waste, signed certificates or receipts (Bill of Lading) from each recycling or destruction facility.

## 1.16 STATEMENT OF COMPLIANCE

The Statement of compliance follows this page.

STATEMENT OF COMPLIANCE

I hereby certify that:

(1) the appropriate state manifest form has been completely and properly filled out;

(2) the packing, marking, labeling and placarding of the waste meets all applicable regulations;

(3) the waste transportation, recycling, destruction and disposal meets all applicable Federal, State and local regulations.

Name_______________________________________________________________

Title______________________________________________________________

Date_______________________________________________________________

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

# SECTION 13721

# SMALL INTRUSION DETECTION SYSTEM
**03/97**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI X3.92 | (1981; R 1993) Data Encryption Algorithm |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 47 CFR 15 | Radio Frequency Devices |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (1997) National Electrical Safety Code |
| IEEE C62.41 | (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits |
| IEEE Std 100 | (1997) IEEE Standard Dictionary of Electrical and Electronics Terms |
| IEEE Std 142 | (1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (1997) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | (1993) Industrial Control and Systems |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2002) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 681 | (1999) Installation and Classification of |

| | |
|---|---|
| | Burglar and Holdup Alarm Systems |
| UL 796 | (1999) Printed-Wiring Boards |
| UL 1037 | (1999) Antitheft Alarms and Devices |
| UL 1076 | (1995; Rev thru Feb 1999) Proprietary Burglar Alarm Units and Systems |

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 General

The Contractor shall configure the Intrusion Detection System (IDS) as described and shown, including Government Furnished Equipment (GFE). Computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in 47 CFR 15.

### 1.2.2 Overall System Reliability Requirement

The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF), as defined in IEEE Std 100, of at least 10,000 hours continuous operation.

### 1.2.3 Definitions

#### 1.2.3.1 Intrusion Alarm

An alarm resulting from the detection of a specified target and which results in an attempt to intrude into the protected area or when entry into an entry controlled area is attempted without successfully using entry control procedures.

#### 1.2.3.2 {AM#0001}<u>DELETED</u>

#### 1.2.3.3 {AM#0001}<u>DELETED</u>

#### 1.2.3.4 False Alarm

An alarm when there is no alarm stimulus.

#### 1.2.3.5 {AM#0001}<u>DELETED</u>

### 1.2.4 {AM#0001}<u>DELETED</u>

### 1.2.5 Standard Intruder and Intruder Movement

The system shall be able to detect an intruder that weighs 45 kg or less and is 1.5 m tall or less. The intruder shall be dressed in a long-sleeved shirt, slacks and shoes unless environmental conditions at the site require protective clothing. Standard intruder movement is defined as any movement such as walking, running, crawling, rolling, or jumping through a protected zone in the most advantageous manner for the intruder.

1.2.6 Electrical Requirements

Electrically powered IDS equipment shall operate on 120 volt 60 Hz AC sources as shown. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

1.2.7 Power Line Surge Protection

Equipment connected to alternating current circuits shall be protected from power line surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

1.2.8 Sensor Wiring and Communication Circuit Surge Protection

Inputs shall be protected against surges induced on sensor wiring. Outputs shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fiber optics, which serve as communications circuits from the console to field equipment, and between field equipment, shall have surge protection circuits installed at each end. Protection shall be furnished at equipment, and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 900 mm of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.2.9 System Reaction

All alarms shall be annunciated on the displays within 1 second of their occurring at a local processor.

1.2.10 Environmental Conditions

1.2.10.1 Interior, Controlled Environment

All system components, except the console, installed in interior locations having controlled environments shall be rated for continuous operation under ambient environmental conditions of 2 to 50 degrees C dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.2.10.2 Interior, Uncontrolled Environment

All system components installed in interior locations having uncontrolled environments shall be rated for continuous operation under ambient environmental conditions of minus 18 to plus 50 degrees C dry bulb and 10 to 95 percent relative humidity, noncondensing.

1.2.10.3 Central Station

All central station equipment shall, unless designated otherwise, be rated for continuous operation under ambient environmental conditions of 16 to 29 degrees C and a relative humidity of 20 to 80 percent.

1.2.11 System Capacity

The system shall monitor and control the number of inputs and outputs shown and shall include an expansion capability of a minimum of 25 percent.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Intrusion Detection System; G, ED.

a. System block diagram.

{AM#0001}_____________________

b. Processor installation, typical block, and wiring diagrams.

c. Details of connections to power sources, including power supplies and grounding.

d. Details of surge protection device installation.

e. Sensor detection patterns.

f. The qualifications of the Manufacturer, Contractor, and Installer to perform the work specified herein.

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Spare Parts; G, ED.

Data lists of spare parts, tools, and test equipment for each different item of material and equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended for stocking.

Manufacturer's Instructions; G, ED.

Printed copies of manufacturer's recommendations for installation of materials prior to installation. Where installation procedures, or any part thereof, are required to be in accordance with manufacturer's recommendations, installation of the item will not be allowed to proceed until the recommendations are received and approved.

Testing; G, ED.

Test plan defining all tests required to ensure that the system meets technical, operational and performance specifications, 60 days prior to proposed test date. The test plan must be approved before the start of any testing. The test plan shall identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

Experience; G, ED.

Written proof of specified experience requirements.

SD-06 Test Reports

Performance Verification Test; G, ED.

Test reports, in booklet form with witness signatures verifying execution of tests. Reports shall show the field tests to verify compliance with the specified performance criteria. Test reports shall include records of the physical parameters verified during testing. Test reports shall be submitted within 14 days after completion of testing.

Materials and Equipment; G, ED.

Where materials or equipment are specified to conform, be constructed or tested to meet specific requirements, certification that the items provided conform to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.

## 1.4 TESTING

The Contractor shall perform site testing and adjustment of the completed intrusion detection system. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the Government at least 14 days prior to the test, and in no case shall notice be given until after the Contractor has received written approval of the specific test procedures.

## 1.5 LINE SUPERVISION

### 1.5.1 Signal and Data Transmission System (DTS) Line Supervision

All signal or DTS lines between sensors and the alarm annunciation console shall be supervised by the system. The system shall supervise the signal lines by monitoring changes in the direct current that flows through the signal lines and a terminating resistor. The system shall initiate an alarm in response to a current change of 10 percent or greater. The system shall also initiate an alarm in response to opening, closing, shorting, or grounding of the signal and DTS lines.

### 1.5.2 Data Encryption

The intrusion detection system shall incorporate data encryption equipment on data transmission media links as shown. The algorithm used for encryption shall be the Data Encryption Standard (DES) algorithm described in ANSI X3.92.

## 1.6 DATA TRANSMISSION SYSTEM (DTS)

The Contractor shall provide data transmission systems as specified in Section 16792 WIRE LINE DATA TRANSMISSION SYSTEM and as shown.

## 1.7 EXPERIENCE

The Contractor shall submit written proof that the following experience requirements are being met.

### 1.7.1 Hardware Manufacturer

All system components shall be produced by manufacturers who have been regularly engaged in the production of intrusion detection system components of the types to be installed for at least 3 years.

### 1.7.2 Software Manufacturer

All system and application software shall be produced by manufacturers who have been regularly engaged in the production of intrusion detection system and application software of similar type and complexity as the specified system for at least 2 years.

### 1.7.3 System Installer

The system shall be installed by a contractor who has been regularly engaged in the installation of intrusion detection systems of similar type and complexity as the specified system for at least 2 years.

PART 2 PRODUCTS

2.1 ACCEPTABLE PRODUCTS

Advantor {AM#0001} Advantage Plus or approved equal. Proposed approved equal shall be 100% compatible with Advantor Advantage Plus.

2.2 GENERAL REQUIREMENTS

2.2.1 Materials and Equipment

Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's model and serial number in a conspicuous place.

2.2.2 Enclosures

System enclosures shall be as shown.

2.2.2.1 Interior Sensor

Sensors to be used in an interior environment shall be housed in an enclosure that provides protection against dust, falling dirt, and dripping noncorrosive liquids.

2.2.2.2 Interior Electronics

System electronics to be used in an interior environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 12.

2.2.2.3 Corrosion Resistant

System electronics to be used in a corrosive environment as defined in NEMA 250 shall be housed in an enclosure which meet the requirements of NEMA 250 Type 4X.

2.2.3 Nameplates

Laminated plastic nameplates shall be provided for local processors. Each nameplate shall identify the local processor and its location within the system. Laminated plastic shall be 3 mm thick, white with black center core. Nameplates shall be a minimum of 25 by 75 mm, with minimum 6 mm high engraved block lettering. Nameplates shall be attached to the inside of the enclosure housing the local processor. Other major components of the system shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a corrosion resistant plate secured to the item of equipment. Nameplates will not be required for devices smaller than 25 by 75 mm.

2.2.4 Tamper Provisions

2.2.4.1 Tamper Switches

Enclosures, cabinets, housings, boxes, and fittings of every description having hinged doors or removable covers and which contain circuits or connections of the intrusion detection system and its power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. The enclosure and the tamper switch shall function together in such a manner as to not allow direct line of sight to any internal components before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware so concealed that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door or cover; and shall be wired so that they break the circuit when the door or cover is disturbed.

a. Nonsensor Enclosures: Tamper switches on nonsensor enclosures, which must be opened to make routine maintenance adjustments to the system and to service the power supplies, shall be push/pull-set, automatic reset type.

b. Sensor Enclosures: Tamper switches on sensor enclosures, which must be opened to make routine maintenance adjustments to the sensor, shall be single pole single throw type.

2.2.4.2 Enclosure Covers

Covers of pull and junction boxes provided to facilitate initial installation of the system need not be provided with tamper switches if they contain no splices or connections, but shall be protected by tack welding or brazing the covers in place or by tamper resistant security fasteners. Labels shall be affixed to such boxes indicating they contain no connections.

2.2.5 Locks and Key-Lock Switches

2.2.5.1 Locks

Locks shall be installed on system enclosures for maintenance purposes. Locks shall be UL listed, round-key type, with three dual, one mushroom, and three plain pin tumblers or conventional key type lock having a combination of five cylinder pin and five-point three position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be so arranged that the key can only be withdrawn when in the locked position. All maintenance locks shall be keyed alike and only two keys shall be furnished for all of these locks. These keys shall be controlled in accordance with the key control plan.

2.2.5.2 Key-Lock-Operated Switches

All key-lock-operated switches required to be installed on system components shall be UL listed, round-key type, with three dual, one mushroom, and three plain pin tumblers. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be two position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only two keys shall be furnished for each key-lock-operated-switch. These keys shall be controlled in accordance with the key control plan.

2.2.5.3 Construction Locks

If the Contractor requires locks during installation and construction, a set of temporary locks shall be used. The final set of locks installed and delivered to the Government shall not include any of the temporary locks.

2.2.6 Application of System Component

System components shall be designed for continuous operation. Electronic components shall be solid state type, mounted on printed circuit boards conforming to UL 796. Printed circuit board connectors shall be plug-in, quick-disconnect type. Power dissipating components shall incorporate safety margins of not less that 25 percent with respect to dissipation ratings, maximum voltages, and current carrying capacity. Light duty relays and similar switching devices shall be solid state type or sealed electro-mechanical.

2.2.6.1 Maintainability

Components shall be designed to be maintained using commercially available tools and equipment. Components shall be arranged and assembled so they are accessible to maintenance personnel. There shall be no degradation in tamper protection, structural integrity, EMI/RFI attenuation, or line supervision after maintenance when it is performed in accordance with manufacturer's instructions. The system shall be configured and installed to yield a mean time to repair (MTTR) of not more than 8 hours. Repair time is the clock time from the time maintenance personnel are given entrance to the system and begin work, until the system is fully functional.

2.2.6.2 Interchangeability

The system shall be constructed with off-the-shelf components which are physically, electrically and functionally interchangeable with equivalent components as complete items. Replacement of equivalent components shall not require modification of either the new component or of other components with which the replacement items are used. Custom designed or one-of-a-kind items shall not be used. Interchangeable components or modules shall not require trial and error matching in order to meet integrated system requirements, system accuracy, or restore complete system functionality.

2.2.6.3 Electromagnetic and Radio Frequency Interference (EMI/RFI)

System components generating EMI/RFI shall be designed and constructed in accordance with 47 CFR 15.

2.2.6.4 Product Safety

System components shall conform to applicable rules and requirements of

NFPA 70. System components shall be equipped with instruction plates, including warnings and cautions, describing physical safety, and special or important procedures to be followed in operating and servicing system equipment.

2.2.7 Controls and Designations

Controls and designations shall be as specified in NEMA ICS 1.

2.2.8 Special Test Equipment

The Contractor shall provide all special test equipment, special hardware, software, tools, and programming or initialization equipment needed to start or maintain any part of the system and its components. Special test equipment is defined as any test equipment not normally used in an electronics maintenance facility.

2.2.9 Alarm Output

The alarm output of each sensor shall be a single pole double throw (SPDT) contact rated for a minimum of 0.25 A at 24 volts DC.

2.2.10 Alarm Indicator Lights

Indicator lights used throughout the system shall be light emitting diodes (LED) or long life incandescent lamps. The indicator lights used shall be visible from a distance of 9 m in an area illuminated to 800 lux (75 foot candles). The indicator lights shall conform to the following color coding:

a. FLASHING RED to alert an operator that a zone has gone into an unacknowledged alarm or that primary power has failed.

b. RED to alert an operator that a zone is in alarm and that the alarm has been acknowledged.

c. YELLOW to advise an operator that a zone is in access.

d. GREEN to indicate that a zone is secure or that power is on.

2.2.11 Access/Secure Devices

Access/secure devices shall be used to place a protected zone in ACCESS. The device shall disable all sensor alarm outputs, with the exception of tamper alarm outputs within the protected zone, and sensors in zones above false ceilings or other inaccessible locations as shown.

2.2.11.1 Switches

The switch shall consist of a double pull key-operated switch housed in a NEMA 12 equivalent enclosure.

2.2.11.2 Key Pads

Secure/Access keypads shall use a unique combination of alphanumeric and other symbols as an identifier. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII code ordinal sequence. The keypad shall have a contact output.

## 2.3 INTERIOR SENSORS

### 2.3.1 Balanced Magnetic Switch (BMS)

The BMS shall detect 6 mm of separating relative movement between the magnet and the switch housing. Upon detecting such movement, it shall transmit an alarm signal to the alarm annunciation system.

#### 2.3.1.1 BMS Subassemblies

The BMS shall consist of a switch assembly and an actuating magnetic assembly. The switch mechanism shall be of the balanced magnetic type. Each switch shall be provided with an overcurrent protective device, rated to limit current to 80 percent of the switch capacity. Switches shall be rated for a minimum lifetime of one million operations. The housings of surface mounted switches and magnets shall be made of nonferrous metal and shall be weatherproof. The housings of recess mounted switches and magnets shall be made of nonferrous metal or plastic.

#### 2.3.1.2 Remote Test

A remote test capability shall be provided. The remote test shall be initiated when commanded by the alarm annunciation system. The remote test shall activate the sensor's switch mechanism causing an alarm signal to be transmitted to the alarm annunciation system. The remote test shall simulate the movement of the actuating magnet relative to the switch subassembly.

### 2.3.2 Microwave Motion Sensor

#### 2.3.2.1 Remote Test, Microwave Signal

A remote test capability shall be provided. The remote test hardware may be integral to the sensor or a separate piece of equipment. The remote test shall be initiated when commanded by the alarm annunciation system. The remote test shall excite the sensing element and associated electronics causing an alarm signal to be transmitted to the alarm annunciation system. The sensor stimulation generated by the remote test hardware shall simulate a standard intruder moving within the sensor's detection pattern.

### 2.3.3 Passive Infrared Motion Sensor

The passive infrared motion sensor shall detect changes in the ambient level of infrared emissions caused by the movement of a standard intruder within the sensor's field of view. Upon detecting such changes, the sensor shall transmit an alarm signal to the alarm annunciation system. The sensor shall detect a change in temperature of no more than 1.1 degrees C, and shall detect a standard intruder traveling within the sensor's detection pattern at a speed of 0.091 to 2.29 m per second across two adjacent segments of the field of view. Emissions monitored by the sensor shall be in the 8 to 14 micron range. The sensor shall be adjustable to obtain the coverage pattern shown. The sensor shall be equipped with a temperature compensation circuit.

2.3.3.1 Test Indicator, Infrared Emissions

The passive infrared motion sensor shall be equipped with an LED walk test indicator. The walk test indicator shall not be visible during normal operations. When visible, the walk test indicator shall light when the sensor detects an intruder. The sensor shall either be equipped with a manual control, located within the sensor's housing, to enable/disable the test indicator or the test indicator shall be located within the sensor such that it can only be seen when the housing is open/removed.

2.3.3.2 Remote Test, Infrared Emissions

A remote test capability shall be provided. The remote test hardware may be integral to the sensor or a separate piece of equipment. The remote test shall be initiated when commanded by the alarm annunciation system. The remote test shall excite the sensing element and associated electronics causing an alarm signal to be transmitted to the alarm annunciation system. The sensor stimulation generated by the remote test hardware shall simulate a standard intruder moving within the sensor's detection pattern.

2.4 FIELD PROCESSING HARDWARE

2.4.1 Alarm Annunciation Local Processor

The alarm annunciation local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station and change outputs based on commands received from the central station. The local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.

a. Inputs. Local processor inputs shall monitor dry contacts for change of state that reflect alarm conditions. The local processor shall have at least 8 alarm inputs which allow wiring as normally open or normally closed contacts for alarm conditions; and shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements. The local processor shall report for any condition that remains off normal at an input for longer than 500 milliseconds. Each alarm condition shall be transmitted to the central computer during the next interrogation cycle.

b. Outputs. Local processor outputs shall reflect the state of commands issued by the central station. The outputs shall be a form C contact and shall include normally open and normally closed contacts. The local processor shall have at least 4 command outputs.

### 2.4.2 Processor Power Supply

Local processor and sensors shall be powered from an uninterruptible power source. The uninterruptible power source shall provide 6 hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored. There will be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa. Batteries shall be sealed, non-outgassing type. The power supply shall be equipped with an indicator for ac input power and an indicator for dc output power. Loss of primary power shall be reported to the central station as an alarm.

### 2.4.3 Auxiliary Equipment Power

A GFI service outlet shall be furnished inside the local processor's enclosure.

## 2.5 FIELD PROCESSING SOFTWARE

All field processing software described in this specification shall be furnished as part of the complete system.

### 2.5.1 Operating System

Each local processor shall contain an operating system that controls and schedules that local processor's activities in real time. The local processor shall maintain a point database in its memory that includes all parameters, constraints, and the latest value or status of all points connected to that local processor. The execution of local processor application programs shall utilize the data in memory resident files. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each local processor real time clock shall be automatically synchronized with the central station clock at least once per day to plus or minus 10 seconds. The time synchronization shall be accomplished without operator intervention and without requiring system shutdown.

#### 2.5.1.1 Startup

The local processor shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected functions. A local processor restart program based on detection of power failure at the local processor shall be included in the local processor software. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made. If the database and application programs are resident, the local processor shall immediately resume operation.

#### 2.5.1.2 Operating Mode

Each local processor shall control and monitor inputs and outputs as specified, independent of communications with the central station. Alarms, status changes and other data shall be transmitted to the central station when communications circuits are operable. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station shall be stored for later transmission to the central station. Storage for the latest 1024 events shall be provided at each local processor. Each local processor shall accept software downloaded from the central station.

2.5.1.3 Failure Mode

Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

2.5.2 Functions

The Contractor shall provide all software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within each local processor.

a. Monitoring of inputs.

b. Control of outputs.

c. Reporting of alarms automatically to central station.

d. Reporting of sensor and output status to central station upon request.

e. Maintenance of real time, updated by the central station at least once a day.

f. Communication with the central station.

g. Execution of local processor resident programs.

h. Diagnostics.

i. Download and upload data to and from the central station.

2.6 WIRE AND CABLE

2.6.1 General

The Contractor shall provide all wire and cable not indicated as Government furnished equipment. All wiring shall meet NFPA 70 standards.

2.6.2 Above Ground Sensor Wiring

Sensor wiring shall be 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware. Multiconductor wire shall have an outer jacket of PVC.

#### 2.6.3 Class 2 Low Energy Conductors

The conductor sizes specified for digital functions shall take precedence over any requirements for Class 2 low energy signal-circuit conductors specified elsewhere.

## PART 3 EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

The Contractor shall install all system components, including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown, and shall furnish necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown.

#### 3.1.1 Installation

The Contractor shall install the system in accordance with the standards for safety, NFPA 70, UL 681, UL 1037 and UL 1076, and the appropriate installation manual for each equipment type. Components within the system shall be configured with appropriate service points to pinpoint system trouble in less than 20 minutes. Minimum size of conduit shall be 13 mm. DTS shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. Flexible cords or cord connections shall not be used to supply power to any components of the system, except where specifically noted herein. All other electrical work shall be as specified in Sections 16415 and as shown. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

#### 3.1.2 Enclosure Penetrations

All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

#### 3.1.3 Cold Galvanizing

All field welds and/or brazing on factory galvanized components, such as boxes, enclosures, and conduits, shall be coated with a cold-galvanized paint containing at least 95 percent zinc by weight.

### 3.2 SYSTEM STARTUP

The Contractor shall not apply power to the intrusion detection system until the following items have been completed:

a. Intrusion detection system equipment items and DTS have been set up in accordance with manufacturer's instructions.

b. A visual inspection of the intrusion detection system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.

c. System wiring has been tested and verified as correctly connected as indicated.

d. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.

e. Power supplies to be connected to the intrusion detection system have been verified as the correct voltage, phasing, and frequency as indicated.

f. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

## 3.3 SITE TESTING

### 3.3.1 General

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform the site testing. The Government will witness all testing. Written permission shall be obtained from the Government before proceeding with the next phase of testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test.

### 3.3.2 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify data transmission system (DTS) operation, place the integrated system in service, and test the integrated system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

### 3.3.3 Performance Verification Test

The Contractor shall demonstrate that the completed system complies with the specified requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown.

The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Government, based on the Contractor's written request. This shall include certification of successful completion of testing as specified in paragraph Contractor's Field Testing, and upon successful completion of training as specified. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation to the Government, as specified. The Contractor will not be held responsible for failures in system performance resulting from the following:

(1) An outage of the main power in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the system performed as specified.

(2) Failure of a Government furnished communications link, provided that the failure was not due to Contractor furnished equipment, installation, or software.

(3) Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

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-- End of Section --

# SECTION 13851

# FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE
**08/98**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI S3.41 | (1990; R 1996) Audible Emergency Evacuation Signals |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 47 CFR 15 | Radio Frequency Devices |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C62.41 | (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2002) National Electrical Code |
| NFPA 72 | (1999; Errata Oct 96, Dec 96; TIA 96-1, 96-2, 96-3) National Fire Alarm Code |
| NFPA 90A | (1999) Installation of Air Conditioning and Ventilating Systems |
| NFPA 1221 | (1999) Installation, Maintenance and Use of Public Fire Service Communication Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 6 | (1997) Rigid Metal Conduit |
| UL 38 | (1994; Rev Nov 1994) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems |
| UL 228 | (1997) Door Closers-Holders, With or |

| | |
|---|---|
| | Without Integral Smoke Detectors |
| UL 268 | (1996; Rev thru Jun 1998) Smoke Detectors for Fire Protective Signaling Systems |
| UL 268A | (1998) Smoke Detectors for Duct Applications |
| UL 464 | (1996; Rev May 1997) Audible Signal Appliances |
| UL 521 | (1993; Rev Oct 1994) Heat Detectors for Fire Protective Signaling Systems |
| UL 797 | (1993; Rev thru Mar 1997) Electrical Metallic Tubing |
| UL 864 | (1996) Control Units for Fire-Protective Signaling Systems |
| UL 1242 | (1996; Rev Mar 1998) Intermediate Metal Conduit |
| UL 1971 | (1995; Rev thru May 1997) Signaling Devices for the Hearing Impaired |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire Alarm Reporting System; G, ED.

Detail drawings, prepared and signed by a Registered Professional Engineer {AM#0001}(as defined by paragraph 1.3.7.3 "Design Services", consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The Contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

SD-03 Product Data

Storage Batteries; G, ED.

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Voltage Drop; G, ED.

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Special Tools and Spare Parts.

Spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Technical Data and Computer Software; G, ED.

Technical data which relates to computer software.

Training.

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing; G, ED.

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

SD-06 Test Reports

Testing; G, ED.

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

SD-07 Certificates

Equipment.

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Qualifications.

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

SD-10 Operation and Maintenance Data

Technical Data and Computer Software; G, ED.

Six copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training. {AM#0001}<u>Provide system software for all fire alarm system programming, including modifying the control panel to add/delete devices and change controls.</u>

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification. Provide year 2000 (Y2K) compliant products and equipment. Provide products and equipment that are not adversely affected by dates prior to, on, or following January 1, 2000.

1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.3.3 Keys and Locks

Locks shall be keyed CAT-15. Substitution of similar keyed locks that can be forcibly opened with a CAT-15 key will not be allowed. Four keys for the system shall be provided.

1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

1.3.5 Verification of Dimensions

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3.6 Compliance

The fire detection and alarm system and the central reporting system shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

1.3.7 Qualifications

1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

1.3.7.2 Installer

The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system. NICET Level 2 or higher Fire Alarm Technician shall install and terminate fire alarm devices, cabinets and panels. An electrician or NICET Level 1 Fire Alarm Technician shall install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.3.7.3 Design Services

Installations requiring designs or modifications of fire detection, fire alarm, or fire suppression systems shall require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of {AM#0001} 5 years' work experience in fire protection engineering.

b. A registered professional engineer (P.E.) {AM#001} who has passed the National Council of Examiners for Engineering and Surveys (NCEE) fire protection engineering written examination.

c. A registered PE in a related engineering discipline {AM#0001} with a minimum of 5 years experience dedicated to fire protection engineering.

d. {AM#0001}DELETED

{AM#0001}If the individual is not a registered fire protection engineer with 5 years experience then a letter submitted on company letterhead shall be submitted whenever documents outlining fire systems or the life safety concerns are provided to the government. Individual shall meet one of the requirements listed above in paragraph a, b, or c.

1.4 SYSTEM DESIGN

1.4.1 Operation

The fire alarm and detection system shall be a complete, supervised fire alarm reporting system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to signal line circuits (SLC), Style 6, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all SLC and NAC circuits will remain functional. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and shall provide the following features:

a. Sufficient memory to perform as specified and as shown for addressable system.

b. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and devices missing/failed remote detector - sensitivity adjustment from the panel for smoke detectors

c. Capability of each addressable device being individually disabled or enabled from the panel.

d. Each SLC shall be sized to provide 40 percent addressable expansion without hardware modifications to the panel.

1.4.2 Operational Features

The system shall have the following operating features:

a. Monitor electrical supervision of SLC, and NAC. Smoke detectors shall have combined alarm initiating and power circuits.

b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.

c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter (Monaco BT2-7)but providing a trouble signal when disconnected and a restoration signal when reconnected.

f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.

g. Electrical supervision for circuits used for supervisory signal services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.

h. Confirmation or verification of all smoke detectors. The control panel shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices other than smoke detectors shall be programmed without confirmation or verification.

i. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided.

j. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.

k. The fire alarm control panel shall monitor and control the fire sprinkler system, or other fire protection extinguishing system.

l. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.

1.4.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

a. Transmission of a signal over the station (Monaco BT2-7) radio fire reporting system.

b. Visual indications of the alarmed devices on the fire alarm control panel display and on the remote audible/visual display.

c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ANSI S3.41.

d. Closure of doors held open by electromagnetic devices.

e. Deactivation of the air handling units throughout the building.

1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

1.4.6 {AM#0001}DELETED

1.4.7 Interface With other Equipment

Interfacing components shall be furnished as required to connect to subsystems or devices which interact with the fire alarm system, such as supervisory or alarm contacts in suppression systems, operating interfaces for HVAC systems, door releases, etc.

1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

PART 2 PRODUCTS

2.1 CONTROL PANEL

Control Panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surfacemounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LED/LCDs, zones, SLC, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panel and shall identify with a word description and id number each device. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted red.

2.1.1 Remote System Audible/Visual Display

Audible appliance shall have a minimum sound level output rating of 85 dBA at 3.05 m and operate in conjunction with the panel integral display. The audible device shall be silenced by a system silence switch on the remote system. The audible device shall be silenced by the system silence switch located at the remote location, but shall not extinguish the visual indication. The remote LED/LCD visual display shall provide identification, consisting of the word description and id number for each device as displayed on the control panel. A rigid plastic, phenolic or metal identification sign which reads "Fire Alarm System Remote Display" shall be provided at the remote audible/visual display. The remote visual appliance located with the audible appliance shall not be extinguished until the trouble or alarm has been cleared.

2.1.2 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

2.1.3 System Expansion and Modification Capabilities

Any equipment and software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

2.1.4 Addressable Control Module

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled.

## 2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located in a separate battery cabinet. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel.

## 2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet.

## 2.4 ADDRESSABLE MANUAL FIRE ALARM STATIONS

Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on semi-flush mounted outlet boxes. Manual stations shall be mounted at 1220 mm. Stations shall be double action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations. Conventional pull stations with addressable modules added shall not be used.

## 2.5 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated. Installed devices shall conform to NFPA 70 hazard classification of the area where devices are to be installed.

2.5.1 Heat Detectors

Heat detectors shall be designed for detection of fire by fixed temperature . Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

2.5.1.1 Fixed Temperature Detectors

Detectors shall be designed for semi-flush outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 57.2 degrees C.. The UL 521 test rating for the fixed temperature detectors shall be rated for 4.57 by 4.57 m.

2.5.2 Smoke Detectors

Smoke detectors shall be designed for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.

2.5.2.1 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

2.5.2.2 Duct Detectors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 2.5 and 20 m/s. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 1.83 m and those mounted below 1.83 m that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown functions specified in Section {AM#0001} 15952 DIRECT DIGITAL CONTROL SYSTEM FOR DYESS AFB. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

## 2.6 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted white. Recessed audible appliances shall be installed with a grill that is painted white.

### 2.6.1 Alarm Bells

Bells shall be surface mounted with the matching mounting back box surface mounted. Bells shall be suitable for use in an electrically supervised circuit. Bells shall be the underdome type producing a minimum output rating of 85 dBA at 3.1 m. Bells used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles. Single stroke, electrically operated, supervised, solenoid bells shall be used for coded applications.

### 2.6.2 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box surface mounted vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least 85 dBA at 3.05 m. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

### 2.6.3 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela. Strobe shall be surface mounted.

### 2.6.4 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

## 2.7 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

### 2.7.1 Electromagnetic Door Hold-Open Devices

Devices shall be attached to the walls unless otherwise indicated. Devices shall comply with the appropriate requirements of UL 228. Devices shall operate on 24 Volt dc power. Compatible magnetic component shall be attached to the door. Under normal conditions, the magnets shall attract and hold the doors open. When magnets are de-energized, they shall release the doors. Magnets shall have a holding force of 111.2 N (25 pounds). Devices shall be UL or FM approved. Housing for devices shall be brushed aluminum or stainless steel. Operation shall be fail safe with no moving parts. Electromagnetic door hold-open devices shall not be required to be held open during building power failure.

### 2.7.2 Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

### 2.7.3 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The SLC wiring shall be copper cable in accordance with the manufacturers requirements. Wiring for fire alarm dc circuits shall be No. 14 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.

### 2.7.4 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

## 2.8 TRANSMITTERS

### 2.8.1 Radio Alarm Transmitters

Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of NFPA 72, NFPA 1221, and 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. The {AM#0001}transmitter shall be a Monaco BT2-7, narrow band RF. At the contractors option, and if UL listed, the transmitter may be housed in the same panel as the fire alarm control panel.

2.8.1.1 Transmitter Power Supply

Each radio alarm transmitter shall be powered by a combination of locally available 120-volt ac power and a sealed, lead-calcium battery.

a. Operation: Each transmitter shall operate from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service, and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic.

b. Battery Power: Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.8.1.2 Radio Alarm Transmitter Housing

Transmitter housing shall be NEMA Type 1. The housing shall contain a lock that is keyed identical to radio alarm transmitter housings on the base. Radio alarm transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.8.1.3 Antenna

The Contractor shall provide omnidirectional, coaxial, halfwave dipole antennas for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 161 km/h. Antennas shall not be mounted to any portion of the building roofing system. Configure antenna to meet the requirements of the Base Fire Alarm Reporting System.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch circuit to each building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel. All wiring shall be in conduit for power, SLC and NAC circutis. <u>All wiring shall be #16 AWG, minimum.</u>

3.1.3 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 300 mm nor more than 2000 mm above the finished floor. Manually operable controls shall be between 900 and 1100 mm above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

3.1.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 300 mm from any part of any lighting fixture. Detectors shall be located at least 900 mm from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 900 mm, sway bracing shall be provided. Detectors installed in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD in a finished, visible location.

3.1.5 Notification Appliances

Notification appliances shall be mounted 2003 mm above the finished floor or 150 mm below the ceiling, whichever is lower.

3.1.6 Annunciator Equipment

Annunciator equipment shall be mounted where indicated on the drawings.

3.1.7 Addressable Control Module

Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. If a supplementary suppression releasing panel is provided, then the monitor modules shall he mounted in a common enclosure adjacent to the suppression releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices. All interconnecting wires shall be supervised unless an open circuit or short circuit abnormal condition does not affect the required operation of the fire alarm system. If control modules are used as interfaces to other systems, such as HVAC or elevator control, they shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits. Control modules that connect to devices shall supervise the notification appliance circuits. Control modules that connect to auxiliary systems or interface with other systems (non-life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform required alarm functions as specified in Section 13930 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION and as indicated on the drawings and as specified herein.

3.2 OVERVOLTAGE AND SURGE PROTECTION

3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

3.2.2 Low Voltage DC Circuits Surge Protection

All NAC, and communication cables/conductors, except fiber optics, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

3.2.3 Signal Line Circuit Surge Protection

All SLC cables/conductors, except fiber optics, shall have surge protection/isolation circuits installed at each point where it exits or enters a building. The circuit shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector/isolator shall be rated to protect the equipment.

## 3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

## 3.4 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

### 3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.

### 3.4.2 Acceptance Test

{AM#0001}<u>A Corps of Engineers (COE) pipe protection engineer shall witness tests and approve installation.</u> Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

a. Test of each function of the control panel.

b. Test of each circuit in both trouble and normal modes.

c. Tests of each alarm initiating devices in both normal and trouble conditions.

d. Tests of each control circuit and device.

e. Tests of each alarm notification appliance.

f. Tests of the battery charger and batteries.

g. Complete operational tests under emergency power supply.

h. Visual inspection of wiring connections.

i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

j. Ground fault

k. Short circuit faults

l. Stray voltage

m. Loop resistance

## 3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period for systems operation shall consist of {AM#0001} 2 training {AM#0001}days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions. In addition, training shall be provided on performance of expansions or modifications to the fire detection and alarm system. The training period for system expansions and modifications shall consist of at least 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests.

-- End of Section --

# SECTION 13930

## WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
**11/99**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 47/A 47M | (1999) Ferritic Malleable Iron Castings |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 135 | (1997c) Electric-Resistance-Welded Steel Pipe |
| ASTM A 183 | (1998) Carbon Steel Track Bolts and Nuts |
| ASTM A 536 | (1999el) Ductile Iron Castings |
| ASTM A 795 | (1997) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.1 | (1998) Cast Iron Pipe Flanges and Flanged Fittings |
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.4 | (1998) Gray Iron Threaded Fittings |
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B18.2.1 | (1996) Square and Hex Bolts and Screws |

| | |
|---|---|
| | (Inch Series) |
| ASME B18.2.2 | (1987; R 1993) Square and Hex Nuts (Inch Series) |

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

| | |
|---|---|
| ASSE 1015 | (1993) Double Check Backflow Prevention Assembly |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA EWW | (1999) Standard Methods for the Examination of Water and Wastewater |
| AWWA B300 | (1999) Hypochlorites |
| AWWA B301 | (1992; Addenda B301a - 1999) Liquid Chlorine |
| AWWA C104 | (1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water |
| AWWA C110 | (1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids |
| AWWA C111 | (1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C151 | (1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids |
| AWWA C203 | (1997; Addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied |
| AWWA M20 | (1973) Manual: Water Chlorination Principles and Practices |

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

| | |
|---|---|
| FM P7825a | (1998) Approval Guide Fire Protection |
| FM P7825b | (1998) Approval Guide Electrical Equipment |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-71 | (1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 13 | (1999) Installation of Sprinkler Systems |
| NFPA 24 | (1995) Installation of Private Fire Service Mains and Their Appurtenances |
| NFPA 1963 | (1998) Fire Hose Connections |

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

| | |
|---|---|
| NICET 1014-7 | (1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL Bld Mat Dir | (1999) Building Materials Directory |
| UL Fire Prot Dir | (1999) Fire Protection Equipment Directory |

## 1.2 GENERAL REQUIREMENTS

Wet pipe sprinkler system shall be provided in all areas of the building. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. {AM#0001}____________Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. The Contractor shall design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

### 1.2.1 Hydraulic Design

The system shall be hydraulically designed as shown on the Contract Drawings. The minimum pipe size for branch lines in gridded systems shall be 32 mm . Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 6 m/s .

#### 1.2.1.1 Hose Demand

An allowance for exterior hose streams as shown on the Contract Drawings shall be added to the sprinkler system demand at the point of connection to the existing system.

#### 1.2.1.2 Basis for Calculations

The design of the system shall be based upon a water supply with a static pressure of 4.69 bars, and a flow of 95.87 at a residual pressure of 3.52 bars. Water supply shall be presumed available at the point of connection to existing. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for copper tubing, 140 for new cement-lined ductile-iron piping.

1.2.2 Sprinkler Spacing

Sprinklers shall be uniformly spaced on branch lines. Maximum spacing per sprinkler shall not exceed limits specified in NFPA 13.

1.3 COORDINATION OF TRADES

Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction. Sprinkler shall be installed over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES::

SD-02 Shop Drawings

Sprinkler System Shop Drawings; G, ED.

Three copies of the Sprinkler System Shop Drawings, no later than 21 days prior to the start of sprinkler system installation. The Sprinkler System Shop Drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1:100 which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

As-Built Shop Drawings; G, RE.

As-built shop drawings, at least 14 days after completion of the Final Tests. The Sprinkler System Drawings shall be updated to reflect as-built conditions after all related work is completed and shall be on reproducible full-size mylar film.

SD-03 Product Data

Fire Protection Related Submittals.

A list of the Fire Protection Related Submittals, no later than 7 days after the approval of the Fire Protection Specialist.

Load Calculations for Sizing Sway Bracing; G, ED.

For systems that are required to be protected against damage from earthquakes, load calculations shall be provided for sizing of sway bracing.

Components and Equipment Data; GED.

Manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, a complete equipment list that includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; G, ED.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Spare PartsG, RE.

Spare parts data shall be included for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

Preliminary Tests Procedures; G, RE.

Proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests.

Final Acceptance Test Procedures; G, RE.

Proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests.

On-site Training Schedule; G, RE.

Proposed On-site Training schedule, at least 14 days prior to the start of related training.

Preliminary Tests; G{AM#0001}, RE.

Proposed date and time to begin Preliminary Tests, submitted with the Preliminary Tests Procedures.

Final Acceptance Test; G, ED.

Proposed date and time to begin Final Acceptance Test, submitted with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates.

Fire Protection Specialist Qualifications; G, ED.

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system drawings and hydraulic calculations.

Sprinkler System Installer Qualifications; G, ED.

The name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

SD-06 Test Reports

Preliminary Tests Report; G, ED.

Three copies of the completed Preliminary Tests Reports, no later that 7 days after the completion of the Preliminary Tests. The Preliminary Tests Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

Final Acceptance Test Report; G, ED.

Three copies of the completed Final Acceptance Tests Reports, no later that 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist {AM#0001}and Dyess AFB Prevention Personnel and/or COE Fire Protection Engineer.

SD-07 Certificates

Fire Protection Specialist Inspection; G, RE.

Concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports.

SD-10 Operation and Maintenance Data

Wet Pipe Sprinkler System.

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour on-site response to a service call on an emergency basis.

1.7 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall be based on the water supply data shown on the drawings. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

## 1.8 FIRE PROTECTION SPECIALIST

Work specified in this section shall be performed under the supervision of and certified by the Fire Protection Specialist. The Fire Protection Specialist shall be an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers{AM#0001}. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

## 1.9 SPRINKLER SYSTEM INSTALLER QUALIFICATIONS

Work specified in this section shall be performed by the Sprinkler System Installer. The Sprinkler System Installer shall be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

## 1.10 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

# PART 2 PRODUCTS

## 2.1 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

## 2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

## 2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and Equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b{AM#0001}. In addition, all equipment shall be listed and approved for its intended use.

## 2.4 UNDERGROUND PIPING COMPONENTS

### 2.4.1 Pipe

Piping from a point 150 mm above the floor to a point 1500 mm outside the building wall shall be ductile iron with a rated working pressure of 1207 kPa conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 1500 mm outside the building walls shall comply with Section 02510 WATER DISTRIBUTION SYSTEM.

### 2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

### 2.4.3 Gate Valve and Indicator Posts

Gate valves for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 900 mm above finished grade. Gate valves and indicator posts shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b.

## 2.5 ABOVEGROUND PIPING COMPONENTS

Aboveground piping shall be steel.

### 2.5.1 Steel Piping Components

#### 2.5.1.1 Steel Pipe

Except as modified herein, steel pipe shall be black as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795, ASTM A 53/A 53M, or ASTM A 135. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

#### 2.5.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

#### 2.5.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 1200 kPa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

#### 2.5.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm thick, and full face or self-centering flat ring type. Bolts shall be squarehead conforming to ASME B18.2.1 and nuts shall be hexagon type conforming to ASME B18.2.2.

### 2.5.2 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b and of the type suitable for the application, construction, and pipe type and sized to be supported.

### 2.5.3 Valves

#### 2.5.3.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

#### 2.5.3.2 Check Valve

Check valve 50 mm and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check valves 100 mm and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

## 2.6 ALARM CHECK VALVE ASSEMBLY

Assembly shall include an alarm check valve, standard trim piping, pressure gauges, bypass, retarding chamber, testing valves, main drain, and other components as required for a fully operational system.

## 2.7 WATERFLOW ALARM

Electrically operated, exterior-mounted, waterflow alarm bell shall be provided and installed in accordance with NFPA 13. Waterflow alarm bell shall be rated 24 VDC and shall be connected to the Fire Alarm Control Panel(FACP) in accordance with Section 13851 FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE.

## 2.8 ALARM INITIATING AND SUPERVISORY DEVICES

### 2.8.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of detecting a sustained flow of 38 L/min or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

### 2.8.2 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

## 2.9 FIRE DEPARTMENT CONNECTION

Fire department connection shall be flush type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a polished brass finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 65 mm diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

## 2.10 SPRINKLERS

Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed spacing limitations. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Orifice of extended coverage sprinklers shall not exceed 13.5 mm .

2.10.1 Concealed Sprinkler

Concealed sprinkler shall be white polyester quick-response type and shall have a nominal 12.7 mm or 13.5 mm orifice.

2.10.2 Recessed Sprinkler

Upright sprinkler shall be chrome-plated white polyester quick-response type and shall have a nominal 12.7 mm or 13.5 mm orifice.

2.10.3 Flush Sprinkler

Flush sprinkler shall be chrome-plated quick-response type and shall have a nominal 12.7 mm or 13.5 mm orifice.

2.10.4 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, quick-response type with nominal 12.7 mm orifice. Pendent sprinklers shall have a polished chrome finish.

2.10.5 Upright Sprinkler

Upright sprinkler shall be brass quick-response type and shall have a nominal 12.7 mm or 13.5 mm orifice.

2.10.6 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 12.7 mm orifice. Sidewall sprinkler shall have a polished chrome finish. Sidewall sprinkler shall be the quick-response type.

2.10.7 Intermediate Level Rack Sprinkler

Intermediate level rack sprinkler shall be of the upright or pendent type with nominal 12.7 mm orifice and minimum "K" factor of 5.5. The sprinkler shall be equipped with a deflector plate to shield the fusible element from water discharged above it.

2.11 {AM#0001}DELETED

2.12 ACCESSORIES

2.12.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

2.12.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 20 mm and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

2.12.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

2.12.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located as indicated.

2.12.5 Identification Sign

Valve identification sign shall be minimum 150 mm wide x 50 mm high with enamel baked finish on minimum 1.214 mm steel or 0.6 mm aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.13 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze{AM#0001}____ or stainless steel body with flanged ends. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 1207 kPa The maximum pressure loss shall be 40 kPa at a flow rate equal to the sprinkler water demand, at the location of the assembly. A test port for a pressure gauge shall be provided both upstream and downstream of the double check backflow prevention assembly valves.

PART 3 EXECUTION

3.1 FIRE PROTECTION RELATED SUBMITTALS

The Fire Protection Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s). The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government.

## 3.2 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Installation of in-rack sprinklers shall comply with applicable provisions of {AM#0001} NFPA 13.

## 3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the sprinkler system periodically during the installation to assure that the sprinkler system is being provided and installed in accordance with the contract requirements. The Fire Protection Specialist shall witness the preliminary and final tests, and shall sign the test results. The Fire Protection Specialist, after completion of the system inspections and a successful final test, shall certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

## 3.4 ABOVEGROUND PIPING INSTALLATION

### 3.4.1 Protection of Piping Against Earthquake Damage

The system piping shall be protected against damage from earthquakes. Seismic protection shall include flexible and rigid couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required by NFPA 13 for protection of piping against damage from earthquakes.

### 3.4.2 Piping in Exposed Areas

Exposed piping shall be installed so as not to diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

### 3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

### 3.4.4 Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 25 mm pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 300 mm . Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling shall not extend more than 25 mm below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 100 mm . Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

3.4.4.1 Pendent Sprinkler Locations

Pendent sprinklers in suspended ceilings shall be a minimum of 150 mm from ceiling grid.

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 750 mm in length shall be individually supported.

3.4.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer.

3.4.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 15 mm.

3.4.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 07840 FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

### 3.4.9 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

### 3.4.10 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 25 mm pipe connected to the remote branch line; a test valve located approximately 2 meters above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

### 3.4.11 Drains

Main drain piping shall be provided to discharge at the location indicated. Auxiliary drains shall be provided as indicated and as required by NFPA 13. When the capacity of trapped sections of pipe is less than 11 liters, the auxiliary drain shall consist of a valve not smaller than 15 mm and a plug or nipple and cap. When the capacity of trapped sections of piping is more than 11 liters, the auxiliary drain shall consist of two 25 mm valves and one 50 x 300 mm condensate nipple or equivalent, located in an accessible location. Tie-in drains shall be provided for multiple adjacent trapped branch pipes and shall be a minimum of 25 mm in diameter. Tie-in drain lines shall be pitched a minimum of 15 mm per 3 mm .

### 3.4.12 Installation of Fire Department Connection

Connection shall be mounted on the exterior wall approximately 900 mm above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

### 3.4.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

## 3.5 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 900 mm . The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 150 mm above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 1500 mm outside the building walls shall meet the requirements of Section 02510 WATER DISTRIBUTION SYSTEM.

3.6 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

3.7 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 13851 Fire Alarm Reporting System, Radio Type. All wiring for supervisory and alarm circuits shall be #14 AWG solid copper installed in metallic tubing or conduit. Wiring color code shall remain uniform throughout the system.

3.8 {AM#0001}DELETED

3.9 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.10 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

3.10.1 Underground Piping

3.10.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less that the calculated maximum water demand rate of the system.

3.10.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with

NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 1.89 liters per hour per 100 gaskets or joints, regardless of pipe diameter.

3.10.2 Aboveground Piping

3.10.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 1400 kPa or 350 kPa in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

3.10.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor shall provide all equipment and instruments necessary to conduct a complete forward flow test, including65 mm diameter hoses, playpipe nozzles, calibrated pressure gauges, and pitot tube gauge. The Contractor shall provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. A metal placard shall be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer's data.

3.10.3 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

3.10.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

3.11 FINAL ACCEPTANCE TEST

Final Acceptance Test shall begin only when the Preliminary Test Report has been approved. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. In addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received. {AM#0001}All test shall be witnessed and approved by Dyess AFB Prevention Office Personnel and/or COE Fire Protection Engineer.

3.12 ON-SITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 8 hours of normal working time and shall start after the system is functionally complete but prior to the Preliminary Tests and Final Acceptance Test. The On-Site Training shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

# SECTION 15075

# IDENTIFICATION OF PIPING
**09/2000**
**AMENDMENT NO. 0001**

## PART 1 GENERAL (NOT APPLICABLE)

## PART 2 PRODUCTS

### 2.1 IDENTIFICATION BAND OR BLOCK PAINTING

Band or block painting shall consist of a minimum of two coats of gloss paint of the same type that is specified for finish painting of the applicable surfaces in Section 09900 PAINTING, GENERAL.

### 2.2 IDENTIFICATION TAGS

Identification tags shall be brass, 40 mm in diameter, with depressed black letters 15 mm high.

### 2.3 BAND OR BLOCK AND LETTER SIZE

The band or block and letter sizes corresponding to the applicable outside diameter of pipe or pipe covering shall be used. Upper case letters and Arabic numerals shall be used. Sizes are as follows:

| Outside Diameter of Pipe or Covering | Width of Color Band or Block | Size of Legend Letters and Numerals |
|---|---|---|
| 20 mm to 32 mm | 200 mm | 15 mm |
| 40 mm to 50 mm | 200 mm | 20 mm |
| 65 mm to 150 mm | 305 mm | 32 mm |
| 200 mm to 250 mm | 610 mm | 65 mm |
| Over 250 mm | 810 mm | 90 mm |

## PART 3 GENERAL

### 3.1 GENERAL

Pipes in exposed areas and in accessible pipe spaces shall be provided with color band and titles adjacent to all valves, except those provided at plumbing fixtures, adjacent to each strainer, at not more than 12 meters spacing on straight pipe runs, adjacent to change in direction, and on both sides where pipes pass through walls or floors. Color code marking shall be of the colors herein designated. At the option of the Contractor, pressure-sensitive pipe markers of the applicable size and color may be used. Where pipes are too small for such application, a brass identification tag will be fastened securely at specified locations. Plumbing and heating piping in finished spaces such as offices and quarters will not be color banded.

## 3.2 APPLICATION

Surface preparation, materials, and application of paint for legends, bands or blocks shall conform to the requirements of the Section 09900 PAINTING, GENERAL. Pressure-sensitive pipe markers shall be applied in accordance with the manufacturer's instructions.

## 3.3 LEGENDS AND BANDS OR BLOCKS

Legends and bands or blocks shall be placed so as to be easily read from operating positions. Adjacent to legend, arrows will be painted to indicate the direction of flow of material under normal operating conditions. The applicable legends and bands or blocks shall be selected from the following:

| Material | Title | Color Letters | Band or Block Background |
|---|---|---|---|
| Boiler Feedwater | B. F. Water | Black | Yellow |
| Gas | Gas | Black | Yellow |
| Material | Title | Color Letters | Band or Block Background |
| Potable Water | Potable Water | Black | Green |
| Condensate | (2) Condensate____Press | Black | Yellow |
| Fire Protection Water | Fire Protection Water | White | Red |
| High Temp. Water Supply | (4) H.T. Water Sup._______ F | Black | Yellow |
| High Temp. Water Return | H. T. Water Return | Black | Yellow |
| Makeup Water | Makeup Water | Black | Green |
| Chilled Water Supply | Chilled Water Supply | Black | Green |
| Chilled Water Return | Chilled Water Return | Black | Green |
| Domestic HW Supply | Hot Water (Domestic) | White | Green |
| Domestic HW Return | Hot Water Recirulation | White | Green |

(Domestic)

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(1) Include maximum working pressure.
(2) Include, HI, MED or LO.
(3) Specify the grade of fuel oil.
(4) Show the maximum working temperature.
(5) Indicate the maximum working pressure.

-- End of Section --

# SECTION 15080

# THERMAL INSULATION FOR MECHANICAL SYSTEMS
**04/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 580/A 580M | (1998) Stainless Steel Wire |
| ASTM B 209M | (2000) Aluminum and Aluminum-Alloy Sheet and Plate (Metric) |
| ASTM C 195 | (1995) Mineral Fiber Thermal Insulating Cement |
| ASTM C 533 | (1995) Calcium Silicate Block and Pipe Thermal Insulation |
| ASTM C 534 | (1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form |
| ASTM C 547 | (1995) Mineral Fiber Pipe Insulation |
| ASTM C 552 | (2000) Cellular Glass Thermal Insulation |
| ASTM C 553 | (1999) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications |
| ASTM C 610 | (1999) Molded Expanded Perlite Block and Pipe Thermal Insulation |
| ASTM C 612 | (2000) Mineral Fiber Block and Board Thermal Insulation |
| ASTM C 647 | (1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation |

| | |
|---|---|
| ASTM C 795 | (1992; R 1998el) Thermal Insulation for Use in Contact With Austenitic Stainless Steel |
| ASTM C 916 | (1985; R 1996el) Adhesives for Duct Thermal Insulation |
| ASTM C 920 | (1998) Elastomeric Joint Sealants |
| ASTM C 921 | (1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation |
| ASTM C 1126 | (1998) Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation |
| ASTM C 1136 | (1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation |
| ASTM E 84 | (2000a) Surface Burning Characteristics of Building Materials |
| ASTM E 96 | (2000) Water Vapor Transmission of Materials |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

| | |
|---|---|
| MICA Insulation Stds | (1993) National Commercial & Industrial Insulation Standards |

## 1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated.

## 1.3 GENERAL QUALITY CONTROL

### 1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

### 1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

### 1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets , facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

### 1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Thermal Insulation Materials; G, ED.

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

## 1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

# PART 2 PRODUCTS

## 2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

### 2.1.1 Adhesives

#### 2.1.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.

2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent or, dispersed in a nonflammable organic solvent which shall not have a fire point below 94 degrees C. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 100 degrees C. The adhesive shall be nonflammable and fire resistant.

2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Nominal 0.4060 mm (0.016 inch) aluminum 25 x 25 mm with factory applied kraft backing. Aluminum shall be ASTM B 209M , Alloy 3003, 3105, or 5005.

2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449/C 449M. All cements that may come in contact with Austenitic stainless steel must include testing per ASTM C 795.

2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 100 mm wide rolls.

### 2.1.7 Staples

Outward clinching type monel. Monel is a nickel rich alloy which has high strength, high ductility, and excellent resistance to corrosion.

### 2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 6.1 N/mm (35 pounds/inch) width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 3.5 N/mm width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials which require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

#### 2.1.8.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes, ducts, or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

#### 2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.4060 mm nominal thickness; ASTM B 209M , Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.3960 mm thick, 12.7 mm wide for pipe under 300 mm diameter and 19.1 mm (3/4 inch) wide for pipe over 300 mm and larger diameter. Aluminum jacket circumferential seam bands shall be 50.8 x 0.4060 mm aluminum matching jacket material. Bands for insulation below ground shall be 19.1 x 0.5080 mm thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburg or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

#### 2.1.8.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.7620 mm.

### 2.1.9 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. All other application and service properties shall be in accordance with ASTM C 647.

2.1.9.1 Vapor Retarder Required

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.9.2 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.10 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Insulation materials shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 34 degrees to plus 16 degrees C for outdoor, indoor, exposed or concealed applications, shall be as follows:

a. Cellular Glass: ASTM C 552, Type II, and Type III. Supply the insulation with manufacturer's recommended factory applied jacket.

b. Flexible Elastomeric Cellular Insulation:ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.

c. Phenolic Insulation: ASTM C 1126, Type III. Phenolic insulations shall comply with ASTM C 795 and with the ASTM C 665 paragraph Corrosiveness. Supply the insulation with manufacturer's recommended factory applied jacket.

d. Mineral Fiber: ASTM C 547

2.2.2 Aboveground Hot Pipeline

Insulation for above 16 degrees C , for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturers recommended factory applied jacket.

a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the insulation with manufacturers recommended factory applied jacket.

b. Calcium Silicate: ASTM C 533, Type I indoor only, or outdoors above 121 degrees C pipe temperature.

c. Cellular Glass: ASTM C 552, Type II and Type III. Supply the insulation with manufacturers recommended factory applied jacket.

d. Flexible Elastomeric Cellular Insulation: ASTM C 534, Type I or II to 93 degrees C service.

e. Phenolic Insulation: ASTM C 1126 Type III to 121 C service shall comply with ASTM C 795. Supply the insulation with manufacturers recommended factory applied jacket.

2.2.3 Above Ground Dual Temperature Pipeline - Outdoor, Indoor - Exposed or Concealed

Selection of insulation for use over a dual temperature pipeline system shall be in accordance with the most limiting/restrictive case. Find an allowable material from paragraph PIPE INSULATION MATERIALS and determine the required thickness from the most restrictive case. Use the thickness listed in paragraphs INSULATION THICKNESS for cold & hot pipe applications.

2.2.4 Below ground Pipeline Insulation

For below ground pipeline insulation the following requirements shall be met.

2.2.4.1 Cellular Glass

ASTM C 552, type II.

2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.3.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, & IV.

2.3.2 Flexible Mineral Fiber

ASTM C 553, Type I,or Type II up to 121 C . ASTM C 1290 Type III.

2.3.3 Cellular Glass

ASTM C 552, Type I.

2.3.4 Phenolic Foam

ASTM C 1126 Type II, shall comply with ASTM C 795.

#### 2.3.5 Flexible Elastomeric Cellular

ASTM C 534 Type II.

### 2.4 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be limited to those listed herein and shall meet the following requirements:

#### 2.4.1 Cold Equipment Insulation

For temperatures below 16 degrees C.

##### 2.4.1.1 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

##### 2.4.1.2 Flexible Elastomeric Cellular Insulation

ASTM C 534, Type II.

##### 2.4.1.3 Phenolic Foam

ASTM C 1126 Type II shall comply with ASTM C 795.

#### 2.4.2 Hot Equipment Insulation

For temperatures above 16 degrees C.

##### 2.4.2.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, IV, or V as required for temperature encountered to 982 degrees C.

##### 2.4.2.2 Flexible Mineral Fiber

ASTM C 553, Type I, II, III, IV, V, VI or VII as required for temperature encountered to 649 degrees C.

##### 2.4.2.3 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

##### 2.4.2.4 Flexible Elastomeric Cellular Insulation

ASTM C 534, Type II, to 93 degrees C.

##### 2.4.2.5 Phenolic Foam

ASTM C 1126 Type II to 121 degrees C. shall comply with ASTM C 795.

#### 2.4.2.6 Molded Expanded Perlite

ASTM C 610.

## PART 3 EXECUTION

### 3.1 APPLICATION - GENERAL

#### 3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

#### 3.1.2 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07840 FIRESTOPPING.

#### 3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

#### 3.1.4 Installation of Flexible Elastomeric Cellular Insulation

Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Insulation with pre-applied adhesive is not permitted. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 93 degrees C. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry. A brush coating of adhesive shall be applied to both butt ends to be joined and to both slit surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

#### 3.1.5 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

#### 3.1.6 Pipes/Ducts/Equipment which Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items, as specified.

### 3.2 PIPE INSULATION INSTALLATION

#### 3.2.1 Pipe Insulation

##### 3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

c. Sanitary drain lines.

d. Air chambers.

##### 3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

a. Pipe insulation shall be continuous through the sleeve.

b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.

c. Where penetrating interior walls, the aluminum jacket shall extend 50 mm beyond either side of the wall and shall be secured on each end with a band.

d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 250 mm above the floor with one band at the floor and one not more than 25 mm from the end of the aluminum jacket.

e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 50 mm above the flashing with a band 25 mm from the end of the aluminum jacket.

f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 50 mm beyond the interior surface of the wall.

g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 50 mm down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

h. For hot water pipes supplying lavatories or other similar heated service which requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 2.0 mm applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 50.0 mm and shall seal the end of the insulation. Glass tape seams shall overlap 25 mm . Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 10 mm .

i. For domestic cold water pipes supplying lavatories or other similar cooling service which requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 2.0 mm . The coating shall extend out onto the insulation 50.0 and shall seal the end of the insulation. Caulk the annular space between the outer surface of the pipe insulation and the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 10 mm .

3.2.1.3 Pipes Passing Through Hangers

a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 50 mm and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 50 mm shall be installed.

b. Horizontal pipes larger than 50 mm at 16 degrees C and above shall be supported on hangers in accordance with MSS SP-69, and

Section 15400 PLUMBING, GENERAL PURPOSE.

c. Horizontal pipes larger than 50 mm and below 16 degrees C shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass or calcium silicate or perlite (above 27 C shall be installed above each shield. The insert shall cover not less than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 50 mm on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 25 mm, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 50 mm on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 25 mm, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 9 m, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 38 mm, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 150 mm and less. Type II sheet insulation used on pipes larger than 150 mm shall not be stretched around the pipe. On pipes larger than 300 mm, adhere insulation directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 1.8 m level shall be protected.

3.2.2 Aboveground Cold Pipelines

The following cold pipelines shall be insulated per Table I minus 34 degrees C to plus 16 degrees C:

a. Domestic cold water.

b. Make-up water.

d. Refrigerant suction lines.

e. Chilled water.

f. Dual temperature water, i.e. HVAC hot/chilled water.

g. Air conditioner condensate drains.

i. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

Table I - Cold Piping Insulation Thickness
Pipe Size (mm)

| Type of Service | Material | Runouts up to 50 mm* | 25 mm & less | 30 50 mm | 65 - 100 mm | 125 - 150 mm | 205 mm & larger |
|---|---|---|---|---|---|---|---|
| Refrigerant suction piping | CG | | 40 | 40 | 40 | 40 | 40 |
| | FC | | 25 | 25 | 25 | 25 | 25 |
| | PF | | 25 | 25 | 25 | 25 | 25 |
| Chilled water supply & return & dual temp piping | CG | 40 | 40 | 40 | 50 | 50 | 50 |
| | FC | 15 | 25 | 25 | 25 | 25 | 25 |
| | PF | 25 | 25 | 25 | 25 | 25 | 25 |
| Cold domestic | CG | 40 | 40 | 40 | 40 | 40 | 40 |

Table I - Cold Piping Insulation Thickness
Pipe Size (mm)

| Type of Service | Material | Runouts up to 50 mm* | 25 mm & less | 30 50 mm | 65 - 100 mm | 125 - 150 mm | 205 mm & larger |
|---|---|---|---|---|---|---|---|
| water, above and below ceilings, & make up water | FC | 10 | 10 | 10 | 10 | 10 | 10 |
| | PF | 25 | 25 | 25 | 25 | 25 | 25 |
| Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap personnel | FC | 15 | 15 | 15 | 15 | 20 | 20 |
| | MF | 15 | 25 | 25 | 40 | 40 | 40 |
| Air conditioning condensate drain located inside building | FC | | 10 | 15 | 15 | N/A | N/A |
| | PF | | 25 | 25 | 25 | N/A | N/A |
| | PC | | 25 | 25 | 25 | N/A | N/A |

*When runouts to terminal units exceed 3.66 m the entire length of runout shall be insulated like the main feed pipe.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
MF - Mineral Fiber
FC - Flexible Elastomeric Cellular

3.2.2.2 Jacket for Mineral Fiber, Cellular Glass, Phenolic Foam, and Polyisocyanurate Foam Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 1.8 m level will be protected.

3.2.2.3 Insulation for Straight Runs (Mineral Fiber, Cellular Glass, Phenolic Foam and Polyisocyanurate Foam)

a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with a vapor retarder coating.

b. Longitudinal laps of the jacket material shall overlap not less than 38 mm. Butt strips 75 mm wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 100 mm centers if not factory self-sealing. If staples are used, they shall be sealed per paragraph 3.2.2.3 e.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 4 degrees and 50 degrees C during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating. The patch shall extend not less than 38 mm past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be coated with vapor retarder coating.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 50 mm or one pipe diameter.

Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of vapor retarder coating with a minimum total thickness of 2.0 mm, applied with glass tape embedded between coats. Tape seams shall overlap 25 mm.The coating shall extend out onto the adjoining pipe insulation 50 mm. Fabricated insulation with a factory vapor retarder jacket shall be protected with two coats of vapor retarder coating with a minimum thickness of 2 mm and with a 50 mm wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 100 mm wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 150 mm from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

The following hot pipelines above 16 degrees C shall be insulated per Table II:

a. Domestic hot water supply & recirculating system.

b. Hot water heating.

3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

LEGEND:

PF - Phenolic Foam

CG - Cellular Glass

MF - Mineral Fiber
FC - Flexible Elastomeric Cellular

Table II - Hot Piping Insulation Thickness
Pipe Size (mm)

| Type of Service (degrees C) | Material | Runouts up to 50 mm* | 25 mm & less | 32 - 50 mm | 65 - 100 mm | 125 - 150 mm | 205 mm & larger |
|---|---|---|---|---|---|---|---|
| Hot domestic | CG | 40 | 40 | 40 | 40 | 40 | 40 |
| water supply | FC | 15 | 25 | 25 | 40 | 40 | 40 |
| & recirculating | PF | 15 | 25 | 25 | 25 | 25 | 25 |
| system & Water | MF | 15 | 40 | 40 | 40 | 40 | 40 |
| defrost lines | | | | | | | |
| (93C max)** | | | | | | | |
| Heating hot | CG | 40 | 40 | 50 | 50 | 65 | 80 |
| water, supply | PF | 15 | 25 | 25 | 25 | 25 | 40 |
| & return, | MF | 15 | 40 | 40 | 50 | 65 | 80 |
| | CS | 25 | 40 | 50 | 65 | 65 | 80 |
| (121 C Max) | | | | | | | |

* When runouts to terminal units exceed 3.66 m, the entire length of runout shall be insulated like the main feed pipe.

** Applied to recirculating sections of service or domestic hot water systems and first 2.4 meters from storage tank for non-recirculating systems.

3.2.3.2 Jacket for Insulated Hot Pipe, Except Pipe Insulated with Flexible Elastomeric Cellular

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

3.2.3.3 Insulation for Straight Runs

a. Insulation shall be applied to the pipe with joints tightly butted.

b. Longitudinal laps of the jacket material shall overlap not less than 38 mm, and butt strips 75 mm wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 100 mm centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 4 degrees and 49 degrees C and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 100 mm centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 38 mm past the break.

f. Flexible elastomeric cellular pipe insulation shall be installed by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Type II sheet insulation when used on pipe larger than 150 mm shall not be stretched around the pipe. On pipes larger than 300 mm, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.3.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates, except as modified herein: 5 for anchors; 10, 11, 12,and 13 for fittings; 14, 15 and 16 for valves; 17 for flanges and unions; and 18 for couplings. Insulation shall be the same as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 50 mm or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of adhesive applied with glass tape embedded between coats. Tape seams shall overlap 25 mm. Adhesive shall extend onto the adjoining insulation not less than 50 mm. The total dry film thickness shall be not less than 2.0 mm.

d. Insulation terminations shall be tapered to unions at a 45-degree angle.

e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, an aluminum jacket or PVC jacket shall be applied. PVC jacketing requires no factory applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished. Flexible elastomeric cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 50 mm at longitudinal and circumferential joints and shall be secured with bands at not more than 300 mm centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 16 degrees C and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 16 degrees C and below abuts an uninsulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 16 degrees C shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 25 mm and the adjoining aluminum jacket not less than 50 mm. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof.

3.2.4.3 PVC Jacket

PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.2.5 Below ground Pipe Insulation

The following shall be included:

a. Chilled Water

b. Domestic hot water.

c. Heating hot water.

3.2.5.1 Type of Insulation

Below ground pipe shall be insulated with 75 mm cellular glass insulation set in a coat of bedding compound as recommended by the manufacturer.

3.2.5.2 Installation of Below ground Pipe Insulation

a. Bore surfaces of the insulation shall be coated with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Coating thickness shall be sufficient to fill surface cells of insulation. Mastic type materials shall not be used for this coating.

b. Stainless steel bands, 19 mm wide by 0.5080 mm thick shall be used to secure insulation in place. A minimum of two bands per section of insulation shall be applied. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 300 mm in diameter. A minimum of two bands per section of insulation shall be applied.

c. Insulation shall terminate at anchor blocks but shall be continuous through sleeves and manholes.

d. At point of entry to buildings, underground insulation shall be terminated 50 mm inside the wall or floor, shall butt tightly against the aboveground insulation and the butt joint shall be sealed with high temperature silicone sealant.

e. Provision for expansion and contraction shall be made in accordance with the insulation manufacturer's recommendations.

f. Flanges, couplings, valves, and fittings shall be insulated with factory premolded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Insulation sections shall be secured in place with wire, bore surfaces coated, and joints sealed as specified.

g. Insulation, including fittings, shall be finished with three coats of asphaltic mastic, with 6 by 5.5 mesh synthetic reinforcing fabric embedded between coats. Fabric shall be overlapped a minimum of 50 mm at joints. Total film thickness shall be a minimum of 4.7 mm. As an alternate, a prefabricated bituminous laminated jacket, reinforced with internal reinforcement mesh, shall be applied to the insulation. Jacketing material and application procedures shall match manufacturer's written instructions.

h. At termination points, other than building entrances, the mastic and cloth or tape shall cover the ends of insulation and extend 50 mm along the bare pipe.

## 3.3 DUCT INSULATION INSTALLATION

Corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket.

### 3.3.1 Duct Insulation Thickness

Duct insulation thickness shall be in accordance with Table III.

Table III - Minimum Duct Insulation (mm)

| | |
|---|---|
| Cold Air Ducts | 50 |
| Relief Ducts | 40 |
| Fresh Air Intake Ducts | 40 |
| | |
| Warm Air Ducts | 50 |
| Relief Ducts | 40 |
| Fresh Air Intake Ducts | 40 |

Maximum thickness for flexible elastomeric cellular insulation shall not exceed 25 mm, and maximum thickness for polyisocyanurate foam insulation shall not exceed 40 mm to comply with ASTM E 84 flame spread/smoke developed ratings of 25/50

Maximum thickness for flexible elastomeric cellular insulation shall not exceed 1 inch and maximum thickness for polyisocyanurate foam insulation shall not exceed 1.5 inch, to comply with ASTM E 84 flame spread/smoke developed ratings of 25/50.

### 3.3.2 Insulation and Vapor Retarder for Cold Air Duct

Insulation and vapor retarder shall be provided for the following cold air ducts and associated equipment.

a. Supply ducts.

b. Return air ducts.

c. Relief ducts.

d. Flexible runouts (field-insulated).

e. Plenums.

f. Fresh air intake ducts.

g. Mixing boxes (field-insulated).

h. Supply fans (field-insulated).

i. Combustion air intake ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 12 kg per cubic meter and rigid type where exposed, minimum density 48 kg per cubic meter. Insulation for round/oval ducts shall be flexible type, minimum density 12 kg per cubic meter with a factory Type I or II jacket; or, a semi rigid board, minimum density 48 kg per cubic meter, , formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered, with a factory applied Type I or II all service jacket. Insulation for exposed ducts shall be provided with either a white, paintable, factory-applied Type I jacket or a vapor retarder jacket coating finish as specified. Insulation on concealed duct shall be provided with a factory-applied Type I or II vapor retarder jacket. The total dry film thickness shall be approximately 2.0 mm.. Duct insulation shall be continuous through sleeves and prepared openings except fire wall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder shall cover the collar, neck, and any uninsulated surfaces of diffusers, registers and grills. Vapor retarder materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with CEGS 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 150 mm wide strips on 300 mm centers.

b. For rectangular and oval ducts, 600 mm (24 inches) and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 400 mm centers and not more than 400 mm from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 400 mm centers and not more than 400 mm from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder jacket joints overlap 50 mm. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 50 mm beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating.

i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and uninsulated surface 50 mm. Pin puncture coatings shall extend 50 mm from the puncture in all directions.

j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 300 mm apart and not more than 75 mm from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 300 mm and larger. One row shall be provided for each side of duct less than 300 mm.

b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed or bent over.

d. Joints in the insulation jacket shall be sealed with a 100 mm wide strip of tape. Tape seams shall be sealed with a brush coat of vapor retarder coating.

e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 50 mm beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.

g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 50 mm. Pin puncture coatings shall extend 50 mm from the puncture in all directions.

h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 12 kg per cubic meter, attached as per MICA standards.

3.3.3 Insulation for Warm Air Duct

Insulation and vapor barrier shall be provided for the following warm air ducts and associated equipment:.

a. Supply ducts.

b. Return air ducts

c. Relief air ducts

d. Flexible runouts (field insulated)

e. Plenums

f. Fresh air intake ducts

g. Mixing boxes

h. Supply fans

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 12 kg per cubic meter; and rigid type where exposed, minimum density 48 kg per cubic meter. Insulation on exposed ducts shall be provided with a white, paintable, factory-applied Type II jacket, or finished with adhesive finish. Flexible type insulation shall be used for round ducts, minimum density 12 kg per cubic meter with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Adhesive finish where indicated to be used shall be accomplished by applying two coats of adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 2.0 mm Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 150 mm wide strips on 300 mm centers.

b. For rectangular and oval ducts 600 mm and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 450 mm centers and not more than 450 mm from duct corner.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 450 mm centers and not more than 450 mm from duct corners.

d. The insulation shall be impaled on the mechanical fasteners where used. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

f. Insulation jacket shall overlap not less than 50 mm at joints and the lap shall be secured and stapled on 100 mm centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 400 mm apart and not more than 150 mm from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 300 mm and larger and a minimum of one row for each side of duct less than 300 mm.

b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin excess clipped and bent over.

d. Joints on jacketed insulation shall be sealed with a 100 mm wide strip of tape and brushed with vapor retarder coating.

e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 50 mm beyond the break or penetration and shall be secured with adhesive and stapled.

f. Insulation terminations and pin punctures shall be sealed with tape and brushed with vapor retarder coating.

g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 12 kg per cubic meter attached by staples spaced not more than 400 mm and not more than 150 mm from the degrees of joints. Joints shall be sealed in accordance with paragraph 3.3.3.2 d.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 16 degrees C, ducts shall be insulated as specified for cold air duct.

3.3.5 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.4 EQUIPMENT INSULATION INSTALLATION

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment which must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Handholes.

b. Boiler manholes.

c. Cleanouts.

d. ASME stamps.

e. Manufacturer's nameplates.

3.4.2 Insulation for Cold Equipment

Cold equipment below 16 degrees C: Insulation shall be furnished on equipment handling media below 16 degrees C including the following:

a. Pumps.

b. Refrigeration equipment parts that are not factory insulated.

c. Drip pans under chilled equipment.

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d. Cold and chilled water pumps.

e. Air handling equipment parts that are not factory insulated.

f. Expansion and air separation tanks.

3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Thicknesses shall be as follows:

a. Equipment handling media between 2 and 16 degrees C: 40 mm thick cellular glass, 25 mm thick flexible elastomeric cellular, 25 mm thick phenolic foam, or 25 mm thick polyisocyanurate foam.

3.4.2.2 Pump Insulation

a. Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

b. Exposed insulation corners shall be protected with corner angles.

c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 2.0 mm. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 300 mm centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Cellular glass and phenolic foam insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound as recommended by the manufacturer.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 2.0 mm.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 150 x 150 mm by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 50 x 50 mm washers or shall be securely banded or wired in place on 300 mm centers.

3.4.2.4 Vapor Retarder

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 2.0 mm. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 16 degrees C including the following:

a. Converters.

b. Heat exchangers.

c. Water heaters.

d. Pumps handling media above 54 degrees C.

e. Hot water storage tanks.

f. Air separation tanks.

g. Unjacketed boilers or parts of boilers.

h. Boiler flue gas connection from boiler to stack (if inside).

3.4.3.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table IV:

Legend

RMF: Rigid Mineral Fiber
FMF: Flexible Mineral Fiber
CS: Calcium Silicate
PL: Perlite
CG: Cellular Glass
FC: Flexible Elastomeric Cellular
PF: Phenolic Foam

TABLE IV
Insulation Thickness for Hot Equipment (mm)

| Equipment handling steam or other media to indicated pressure or temperature limit | Material | Thickness |
|---|---|---|
| 103.4 kPa | RMF | 50 mm |
| or | FMF | 50 mm |
| 121 C | CS/PL | 100 mm |
| | CG | 75 mm |
| | PF | 40 mm |
| | FC(<93 C) | 25 mm |
| | PC | 25 mm |
| 1379.0kPa | RMF | 75 mm |
| or | FMF | 75 mm |
| 204 C | CS/PL | 100 mm |
| | CG | 100 mm |
| 316 C | RMF | 125 mm |
| | FMF | 150 mm |
| | CS/PL | 150 mm |
| | CG | 150 mm |

316 C: Thickness necessary to limit the external temperature of the insulation to 50 C, except that diesel engine exhaust piping and mufflers shall be covered with 150 mm thick material suitable for 650 degrees C service. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.

3.4.3.2 Insulation of Pumps

Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing which does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 2.0 mm. Caulking shall be applied to parting line of the removable sections and penetrations.

3.4.3.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 300 mm centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.

d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.

e. Exposed insulation corners shall be protected with corner angles.

f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 150 x 150 mm by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 50 x 50 mm washers or shall be securely banded or wired in place on 300 mm (maximum) centers.

g. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 2.0 mm. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.4 Equipment Handling Dual Temperature Media

Below and above 16 degrees C: equipment handling dual temperature media shall be insulated as specified for cold equipment.

3.4.5 Equipment Exposed to Weather

3.4.5.1 Installation

Equipment exposed to weather shall be insulated and finished in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

-- End of Section --

# SECTION 15181

# CHILLED AND CONDENSER WATER PIPING AND ACCESSORIES
**12/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.22 | (1999) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 106 | (1999el) Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A 182/A 182M | (2001) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A 183 | (1998) Carbon Steel Track Bolts and Nuts |
| ASTM A 193/A 193M | (2001a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A 47/A 47M | (1999) Ferritic Malleable Iron Castings |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 536 | (1999el) Ductile Iron Castings |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 733 | (1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples |
| ASTM B 117 | (1997) Operating Salt Spray (Fog) Apparatus |

| | |
|---|---|
| ASTM B 32 | (1996) Solder Metal |
| ASTM B 62 | (1993) Composition Bronze or Ounce Metal Castings |
| ASTM B 75M | (1999) Seamless Copper Tube (Metric) |
| ASTM B 813 | (2000) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube |
| ASTM B 88 | (1999) Seamless Copper Water Tube |
| ASTM D 2000 | (1999) Rubber Products in Automotive Applications |
| ASTM D 3308 | (1997) PTFE Resin Skived Tape |
| ASTM D 520 | (2000) Zinc Dust Pigment |
| ASTM E 84 | (2001) Surface Burning Characteristics of Building Materials |
| ASTM F 1007 | (1986; R 1996) Pipe-Line Expansion Joints of the Packed Slip Type for Marine Application |
| ASTM F 1120 | (1987; R 1998) Circular Metallic Bellows Type Expansion Joints for Piping Applications |
| ASTM F 1199 | (1988; R 1998) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum) |

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

| | |
|---|---|
| ASSE 1003 | (1995) Water Pressure Reducing Valves for Domestic Water Supply Systems |
| ASSE 1017 | (1986) Temperature Actuated Mixing Valves for Primary Domestic use |

AMERICAN WATER WORKS ASSOCIATION(AWWA)

| | |
|---|---|
| AWWA C606 | (1997) Grooved and Shouldered Joints |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8 | (1992) Filler Metals for Brazing and Braze Welding |
| AWS Brazing Hdbk | (1991) Brazing Handbook |

| | |
|---|---|
| AWS D1.1 | (2000) Structural Welding Code - Steel |
| AWS Z49.1 | (1999) Safety in Welding and Cutting |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.18 | (1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.22 | (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (1988) Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.39 | (1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300 |
| ASME B16.5 | (1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24 |
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B31.1 | (1998) Power Piping |
| ASME B31.9 | (1996) Building Services Piping |
| ASME B40.1 | (1991) Gauges - Pressure Indicating Dial Type - Elastic Element |
| ASME BPVC SEC IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |
| ASME BPVC SEC VIII D1 | (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage |

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

| | |
|---|---|
| EJMA Stds | (1998; 7th Edition) EJMA Standards |

HYDRAULIC INSTITUTE (HI)

| | |
|---|---|
| HI 1.1-1.5 | (1994) Centrifugal Pumps |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-110 | (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |
| MSS SP-25 | (1998) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (1993) Pipe Hangers and Supports - Materials, Design and Manufacture |
| MSS SP-67 | (1995) Butterfly Valves |
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |
| MSS SP-70 | (1998) Cast Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-71 | (1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends |
| MSS SP-72 | (1999) Ball Valves with Flanged or Butt-Welding Ends for General Service |
| MSS SP-78 | (1998) Cast Iron Plug Valves, Flanged and Threaded Ends |
| MSS SP-80 | (1997) Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-85 | (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (1997) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA MG 1 | (1998) Motors and Generators |
| NEMA MG 2 | (1989) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | (1999) Installation of Air Conditioning |

and Ventilating Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Piping System; G, ED.

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be provided for the following components as a minimum:

a. Piping and Fittings

b. Valves and Accessories

c. Expansion Joints

d. Pumps

e. Expansion Tanks

f. Air Separator Tanks

g. Pipe Hangers, Inserts, and Supports

Water Treatment Systems; G, ED.

Six complete copies, at least 5 weeks prior to the purchase of the water treatment system, of the proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph "Water Analysis", a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

Spare Parts; G, ED.

Spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Qualifications; G, RE.

3 copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

Field Tests; G, RE.

A schedule, at least 2 weeks prior to the start of related testing, for each test. The schedules shall identify the proposed date, time, and location for each test.

Demonstrations; G, RE

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

Verification of Dimensions; G, RE.

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

SD-06 Test Reports

Field Tests; G, RE.

Six copies of the report shall be provided in bound 216 x 279 mm (8 1/2 x 11 inch) booklets. Reports shall document all phases of the tests performed. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

One-Year Inspection; G, RE.

Six copies of an inspection report, at the completion of one year of service, in bound 216 x 279 (81/2 x 11 inch) inch booklets. The report shall identify the condition of each cooling tower and condenser. The report shall also include a comparison of the condition of the cooling tower and condenser with the manufacturer's recommended operating conditions. The report shall identify all actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.

SD-07 Certificates

Service Organization; G, RE.

A certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

SD-10 Operation and Maintenance Data

Operation Manuals; G, ED.

Six complete copies of an operation manual in bound 216 x 279 (81/2 x 11 inch) booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manuals; G, ED.

Six complete copies of maintenance manual in bound 216 x 279 (81/2 x 11 inch) booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping layouts and simplified wiring and control diagrams of the system as installed.

## 1.3 QUALIFICATIONS

Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made, as a permanent record. Structural members shall be welded in accordance with Section 05090A WELDING, STRUCTURAL.

## 1.4 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

## 1.6 PROJECT/SITE CONDITIONS

### 1.6.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

### 1.6.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

# PART 2 PRODUCTS

## 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

## 2.2 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

## 2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 746 kW (1 hp) and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.4 PIPING SYSTEM

System design, component selection, and system installation, including pressure containing parts and material, shall be based upon a minimum service pressure of 862 kPa at 66 degrees C ; minimum ANSI Class 125. Chilled and condenser water piping shall be steel pipe with the exception that piping 100 mm and smaller may be copper tubing.

## 2.5 STEEL PIPE

Steel pipe shall conform to ASTM A 53/A 53M, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

### 2.5.1 Fittings and End Connections (Joints)

Fittings and end connections shall be as defined herein, except as identified elsewhere. Piping and fittings 25 mm (1 inch) and smaller shall have threaded connections. Piping and fittings larger than 25 mm (1 inch) and smaller than 80 mm (3 inches) shall have either threaded, grooved, or welded connections. Piping and fittings 80 mm (3 inches) and larger shall have grooved, welded, or flanged connections. Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C . Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

#### 2.5.1.1 Threaded Connections

Threaded valves and pipe connections shall conform to ASME B1.20.1.

Threaded fitting shall conform to ASME B16.3. Threaded unions shall conform to ASME B16.39. Threaded pipe nipples shall conform to ASTM A 733.

#### 2.5.1.2 Flanged Connections

Flanges shall conform to ASTM A 182/A 182M and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1.59 mm (1/16 inch) thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

#### 2.5.1.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol.

#### 2.5.1.4 Grooved Mechanical Connections

Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming ASTM A 106, Grade B or ASTM A 53/A 53M. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C (230 degrees F) or Grade No. M3BA610A15B44Z for circulating medium up to 93 degrees C (200 degrees F) . Grooved mechanical connections shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183. Pipe connections and fittings shall be the product of the same manufacturer.

#### 2.5.1.5 Dielectric Waterways and Flanges

Dielectric waterways shall have a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Dielectric waterways shall be constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

## 2.6 COPPER PIPE

Copper pipe shall conform to ASTM B 88M , Type K or L.

### 2.6.1 Fittings and End Connections (Joints)

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75M . Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.6.1.1 Grooved Mechanical Connections

Grooved mechanical joints and fittings shall be designed for not less than 862 kPa service and shall be the product of the same manufacturer. Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A 536. Gaskets for use in grooved joints shall be molded synthetic polymer of pressure responsive design and shall conform to ASTM D 2000 for circulating medium up to 110 degrees C . Grooved joints shall conform to AWWA C606. Coupling nuts and bolts for use in grooved joints shall be steel and shall conform to ASTM A 183. Pipe connections and fittings shall be the product of the same manufacturer.

2.6.2 Solder

Solder shall conform to ASTM B 32, grade Sb5, tin-antimony alloy for service pressures up to 1034 kPa . Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

2.6.3 Brazing Filler Metal

Filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.7 VALVES

Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 3 m or higher above the floor. Valves in sizes larger than 25 mm (1 inch) and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

2.7.1 Gate Valve

Gate valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, soldered, or flanged ends. Gate valves 80 mm (3 inches) and larger shall conform to MSS SP-70, Type I, II, Class 125, Design OF and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.7.2 Globe and Angle Valve

Globe and angle valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends.

Globe and angle valves 80 mm (3 inches) and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged or threaded ends.

2.7.3 Check Valve

Check valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 80 mm (3 inches) and larger shall conform to MSS SP-71, Type I, II, III, or IV, Class 125 or 150 and shall be cast iron with bronze trim and flanged or threaded ends.

2.7.4 Butterfly Valve

Butterfly valves shall be in accordance with MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves shall be bubble tight at 1,000 kPa . Valve bodies shall be cast iron, malleable iron, or steel. Valves smaller than 200 mm (8 inches) shall have throttling handles with a minimum of seven locking positions. Valves 200 mm (8 inches) and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.7.5 Plug Valve

Plug valves 50 mm (2 inches) and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 50 mm (2 inches) and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valve shall a weatherproof operators with mechanical position indicators. Valves 200 mm (8 inches) or larger shall be provided with manual gear operators with position indicators.

2.7.6 Ball Valve

Ball valves 15 mm (1/2 inch) and larger shall conform to MSS SP-72 or MSS SP-110 and shall be ductile iron or bronze with threaded, soldered, or flanged ends. Valves 200 mm (8 inches) or larger shall be provided with manual gear operators with position indicators.

2.7.7 Calibrated Balancing Valve

Valve shall be calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valve's Cv rating shall be as indicated. Valve bodies shall be provided with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter, suitable for the operating pressure specified, shall be provided. The meter shall be complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

2.7.8 Pump Discharge Valve

Valve shall shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valve shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Valve shall have an integral pointer which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 50 mm (2 inches) shall have NPT connections. Valves 50 mm (2 inches) and larger shall have flanged or grooved end connections. Valve design shall allow the back seat for the stem to be replaced in the field under full line pressure. Valve's Cv rating shall be as indicated.

2.7.9 Temperature-Mixing Valve

Valve shall be in accordance with ASSE 1017 for water service.

2.7.10 Pressure-Reducing Valve

Valve shall be in accordance with ASSE 1003 for water service.

2.7.11 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve shall be in accordance with ANSI Z21.22 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

2.7.12 Drain Valves

Valves shall be the gate valve type which are in accordance with MSS SP-80. Valve shall be manually-operated, 20 mm pipe size and above with a threaded end connection. Valve shall be provided with a water hose nipple adapter. Frost-free type valves shall be provided in installations exposed to freezing temperatures.

2.7.13 Air Vents

Manually-operated general service type air vents shall be brass or bronze valves which are furnished with threaded plugs or caps. Automatic type air vents shall be the ball-float type with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat. Air vents on water coils shall have not less than 3 mm threaded end connections. Air vents on water mains shall have not less than 20 mm threaded end connections. Air vents on all other applications shall have not less than 15 mm threaded end connections.

## 2.8 PIPING ACCESSORIES

### 2.8.1 Strainer

Strainer shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 0.8 mm (22 gauge) corrosion-resistant steel, with small perforations numbering not less than 60 per square centimeter (400 per square inch) to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

### 2.8.2 Combination Strainer and Suction Diffuser

Unit shall consist of an angle type body with removable strainer basket and straightening vanes, a suction pipe support, and a blowdown outlet. Strainer shall be in accordance with ASTM F 1199, except as modified herein. Unit body shall have arrows clearly cast on the sides indicating the direction of flow. Strainer screen shall be made of minimum 0.8 mm (22 gauge) corrosion-resistant steel, with small perforations numbering not less than 60 per square centimeter (400 per square inch) to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations.

### 2.8.3 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 862 kPa (125 psig) or 1034 kPa (150 psig) service as appropriate for the static head plus the system head, and 120 degrees C, for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

### 2.8.4 Pressure and Vacuum Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.8.5 Temperature Gauges

Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Celsius scale in 1 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 1.5 m of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 1.5 to 2.1 m above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 2.1 m above the finished floor.

2.8.5.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 229 mm (9 inches) long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.8.5.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 89 mm (3-1/2 inches), stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

2.8.5.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 89 mm (3-1/2 inches), stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.8.5.4 Thermal Well

Thermal well shall be identical size, 15 or 20 mm (1/2 or 3/4 inch) NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 15 mm (1/2 inch) NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 25 mm .

2.8.6 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

2.8.7 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.8.8 Expansion Joints

2.8.8.1 Slip-Tube Type

Slip-tube expansion joints shall be in accordance with ASTM F 1007, Class I or II. Joints shall be provided with internally-externally alignment guides, injected semi-plastic packing, and service outlets. End connections shall be flanged or beveled for welding as indicated. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer.

2.8.8.2 Flexible Ball Type

Flexible ball expansion joints shall be capable of 360 degrees rotation plus 15 degrees angular flex movement. Joints shall be constructed of carbon steel with the exterior spherical surface of carbon steel balls plated with a minimum 0.12 mm of hard chrome in accordance with EJMA Stds and ASME B31.1. Joint end connections shall be threaded for piping 50 mm (2 inches) or smaller. Joint end connections larger than 50 mm (2 inches) shall be grooved, flanged, or beveled for welding. Joint shall be provided with pressure-molded composition gaskets suitable for continuous operation at twice design temperature.

2.8.8.3 Bellows Type

Bellows expansion type joints shall be in accordance with ASTM F 1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections shall be grooved, flanged, or beveled for welding. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint.

2.9 PUMPS

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.5. Pump capacity, efficiency, motor size, and impeller type shall be as indicated on the drawings. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be open, and have sufficient wattage (horsepower) for the service required. Pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

2.9.1 Construction

Shaft seal shall be mechanical-seal or stuffing-box type. Impeller shall be statically and dynamically balanced. Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 862 kPa (125 psig) . Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water. Pump and motor shall be mounted on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings. Pump shall be provided with shaft coupling guard. Close coupled pumps shall be provided with drip pockets and tapped openings. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 180 kPa , the pump speed shall not exceed 1,750 rpm. Pump shall be accessible for servicing without disturbing piping connections.

2.9.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone separator in line.

2.9.3 Stuffing-Box Type Seals

Stuffing box shall include minimum 4 rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.10 EXPANSION TANKS

Tank shall be welded steel, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 862 kPa and precharged to the minimum operating pressure. Tank shall have a replaceable diaphragm and be the captive air type. Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.11 AIR SEPARATOR TANKS

External air separation tank shall have an internal design suitable for creating the required vortex and subsequent air separation. Tank shall be steel, constructed, tested, and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 862 kPa . Tank shall have tangential inlets and outlets connections, threaded for 50 mm and smaller and flanged for sizes 65 mm and larger. Air released from a tank shall be vented as indicated. Tank shall be provided with a blow-down connection.

## 2.12 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited.

### 2.12.1 Chilled {AM#0001}__________Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

### 2.12.2 Chilled Water System

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping. Contractor shall provide inmbitors for initial fill of the system up start-up.

## 2.13 FABRICATION

### 2.13.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

### 2.13.2 Factory Applied Insulation

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

## 2.14 SUPPLEMENTAL COMPONENTS/SERVICES

### 2.14.1 Drain and Make-Up Water Piping

Piping and backflow preventers shall comply with the requirements of Section 15400A PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer system shall be connected by means of an indirect waste.

### 2.14.2 Cathodic Protection

Cathodic protection systems shall be in accordance with Section 13110A CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE).

### 2.14.3 Field Applied Insulation

Field applied insulation shall be provided and installed in accordance with Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

### 3.1.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

### 3.1.2 Functional Requirements

Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall not be less than 2 mm in 1 m . Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 65 mm (2-1/2 inches) or less in diameter, and with flanges for pipe 80 mm (3 inches) and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges. Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

#### 3.1.3 Fittings and End Connections

##### 3.1.3.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

##### 3.1.3.2 Brazed Connections

Brazing shall be performed in accordance with AWS Brazing Hdbk, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

##### 3.1.3.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

##### 3.1.3.4 Grooved Mechanical Connections

Grooves shall be prepared in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.1.3.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.3.6 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

3.1.4 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.5 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.6 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.7 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.8 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 25 mm .

### 3.1.9 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

#### 3.1.9.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

#### 3.1.9.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

#### 3.1.9.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

#### 3.1.9.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

#### 3.1.9.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 100 mm (4 inches) and larger when the temperature of the medium is 16 degrees C or higher. Type 40 shields shall be used on all piping less than 100 mm (4 inches) and all piping 100 mm (4 inches) and larger carrying medium less than 16 degrees C . A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 50 mm (2 inches) and larger.

#### 3.1.9.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg shall have the excess hanger loads suspended from panel points.

3.1.9.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m , not more than 2.4 m from end of risers, and at vent terminations.

3.1.9.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.9.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger, a Type 39 saddle shall be used. On piping under 100 mm (4 inches), a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.9.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm, or by an amount adequate for the insulation, whichever is greater.

3.1.9.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.9.12 Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Section 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05120A STRUCTURAL STEEL.

3.1.9.13 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05120A STRUCTURAL STEEL.

3.1.10 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m on each side of each expansion joint, and in lines 100 mm (4 inches) or smaller not more than 600 mm on each side of the joint.

3.1.11 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.1.12 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 1.0 mm (20 gauge) . Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53/A 53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 13 mm depth. Sleeves shall not be installed in structural members.

3.1.12.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 6.35 mm all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07900A JOINT SEALING.

3.1.12.2 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a 5.17 kg/sq. m. (17 ounce) copper sleeve, or a 0.81 mm (0.032 inch) thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 200 mm from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 50 mm above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 250 mm in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.12.3 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07840A FIRESTOPPING.

3.1.12.4 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.13 Pumps

Support, anchor, and guide so that no strains are imposed on pump by weight or thermal movement of piping. Air vents on pump casings shall be provided. Drain outlets on pump bases shall be piped to the nearest floor or other acceptable drains, with necessary clean-out tees.

3.1.14 Access Panels

Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500A MISCELLANEOUS METAL.

3.1.15 Field Applied Insulation

Field installed insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.16 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

3.1.16.1 Color Coding

Color coding for piping identification is specified in Section {AM#0001} 15075 IDENTIFICATION OF PIPING.

3.1.16.2 Color Coding Scheme

A color coding scheme for locating hidden piping shall be in accordance with Section 15400A PLUMBING, GENERAL PURPOSE and Section 15075 {AM#0001} IDENTIFICATION OF PIPING.

3.2 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.3 FIELD TESTS

Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.3.1 Hydrostatic Tests

Following the cleaning procedures defined above, all chilled and condenser water piping systems shall be hydrostatically tested as defined herein. Unless otherwise agreed by the Contracting Officer, water (or glycol solution) shall be the test medium.

3.3.1.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the test pressure shall be properly isolated.

3.3.1.2 Tests

Piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a calibrated, test pressure gauge. Leaks shall be repaired and piping retested until test is successful. No loss of pressure shall be allowed. Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

3.3.2 Backflow Prevention Assemblies Tests

Backflow prevention assemblies shall be tested in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

3.4 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

3.5 ONE-YEAR INSPECTION

At the conclusion of the one year period, each connecting liquid chiller condenser shall be inspected for problems due to corrosion, scale, and biological growth. If the equipment is found not to conform to the manufacturers recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

-- End of Section --

# SECTION 15182

# REFRIGERANT PIPING
**12/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

| | |
|---|---|
| ARI 710 | (1995) Liquid-Line Driers |
| ARI 720 | (1997) Refrigerant Access Valves and Hose Connectors |
| ARI 750 | (1994) Thermostatic Refrigerant Expansion Valves |
| ARI 760 | (1994) Solenoid Valves for Use With Volatile Refrigerants |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 193/A 193M | (2001a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A 334/A 334M | (1999) Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B 117 | (1997) Operating Salt Spray (Fog) Apparatus |
| ASTM B 280 | (1999) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service |
| ASTM B 32 | (1996) Solder Metal |

| | |
|---|---|
| ASTM B 62 | (1993) Composition Bronze or Ounce Metal Castings |
| ASTM B 75 | (1999) Seamless Copper Tube |
| ASTM B 813 | (2000) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube |
| ASTM D 3308 | (1997) PTFE Resin Skived Tape |
| ASTM D 520 | (2000) Zinc Dust Pigment |
| ASTM E 84 | (2001) Surface Burning Characteristics of Building Materials |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 15 | (1994) Safety Code for Mechanical Refrigeration |
| ASHRAE 17 | (1998) Method of Testing for Capacity Rating of Thermostatic Refrigerant Expansion Valves |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8 | (1992) Filler Metals for Brazing and Braze Welding |
| AWS Brazing Hdbk | (1991) Brazing Handbook |
| AWS D1.1 | (2000) Structural Welding Code - Steel |
| AWS Z49.1 | (1999) Safety in Welding and Cutting |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.22 | (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (1988) Cast Copper Alloy Fittings for Flared Copper Tubes |

| | |
|---|---|
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.5 | (1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24 |
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B31.1 | (1998) Power Piping |
| ASME B31.5 | (1992; B31.5a1994) Refrigeration Piping |
| ASME B31.9 | (1996) Building Services Piping |
| ASME B40.1 | (1991) Gauges - Pressure Indicating Dial Type - Elastic Element |
| ASME BPVC SEC IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (1993) Pipe Hangers and Supports - Materials, Design and Manufacture |
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Refrigerant Piping System; G, RE.

Drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

a. Piping layouts which identify all valves and fittings.

b. Plans and elevations which identify clearances required for maintenance and operation.

SD-03 Product Data

Refrigerant Piping System; G, ED.

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be provided for the following components as a minimum:

a. Piping and Fittings

b. Valves

c. Piping Accessories

d Pipe Hangers, Inserts, and Supports

Spare Parts.

Spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Qualifications.

3 copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

Refrigerant Piping Tests; G, RE.

A schedule, at least 2 weeks prior to the start of related testing, for each test. The schedules shall identify the proposed date, time, and location for each test.

Demonstrations.

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

Verification of Dimensions.

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

SD-06 Test Reports

Refrigerant Piping Tests.

Six copies of the report shall be provided in bound 216 x 279 mm (8 1/2 x 11 inch) booklets. Reports shall document all phases of the tests performed. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

SD-07 Certificates

Service Organization.

A certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

SD-10 Operation and Maintenance Data

Operation Manuals; G, RE.

Six complete copies of an operation manual in bound 216 x 279 (81/2 x 11 inch) booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manuals; G, RE.

Six complete copies of maintenance manual in bound 216 x 279 (81/2 x 11 inch) booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping layouts and simplified wiring and control diagrams of the system as installed.

## 1.3 QUALIFICATIONS

Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made, as a permanent record. Structural members shall be welded in accordance with Section 05090A WELDING, STRUCTURAL.

## 1.4 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

## 1.6 PROJECT/SITE CONDITIONS

### 1.6.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

### 1.6.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

# PART 2 PRODUCTS

## 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

## 2.2 ELECTRICAL WORK

Electrical equipment and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Field wiring shall be in accordance with manufacturer's instructions. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.3 REFRIGERANT PIPING SYSTEM

Refrigerant piping, valves, fittings, and accessories shall be in accordance with ASHRAE 15 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

## 2.4 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

### 2.4.1 Steel Pipe

Steel pipe for refrigerant service shall conform to ASTM A 53/A 53M, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

#### 2.4.1.1 Welded Fittings and Connections

Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol. Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9.

#### 2.4.1.2 Threaded Fittings and Connections

Threaded fitting shall conform to ASME B16.3. Threaded valves and pipe connections shall conform to ASME B1.20.1.

#### 2.4.1.3 Flanged Fittings and Connections

Flanges shall conform to ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1.59 mm (1/16 inch) thickness, full face or self-centering flat ring type. This gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

### 2.4.2 Steel Tubing

Tubing shall be cold-rolled, electric-forged, welded-steel in accordance with ASTM A 334/A 334M, Grade 1. Joints and fittings shall be socket type provided by the steel tubing manufacturer.

2.4.3 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 35 mm (1-3/8 inches) . Joints shall be brazed except that joints on lines 22 mm (7/8 inch) and smaller may be flared. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75M . Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

2.4.4 Solder

Solder shall conform to ASTM B 32, grade Sb5, tin-antimony alloy for service pressures up to 1034 kPa . Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

2.4.5 Brazing Filler Metal

Filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.5 VALVES

Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 25 mm and smaller shall have brazed or socket welded connections. Valves larger than 25 mm shall have tongue-and-groove flanged or butt welded end connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

2.5.1 Refrigerant Stop Valves

Valve shall be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing shall be replaceable under line pressure. Valve shall be provided with a handwheel or wrench operator and a seal cap. Valve shall be the straight or angle pattern design as indicated.

2.5.2 Check Valves

Valve shall be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve shall be provide with resilient seat.

2.5.3 Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 2760 kPa (400 psi) and a maximum operating pressure differential of at least 1375 kPa (200 psi) at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

2.5.4 Expansion Valves

Valve shall conform to ARI 750 and ASHRAE 17. Valve shall be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 degrees C (2 degrees F) of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

2.5.5 Safety Relief Valves

Valve shall be the two-way type, unless indicated otherwise. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

2.5.6 Evaporator Pressure Regulators, Direct-Acting

Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 1 degrees C change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

2.5.7 Refrigerant Access Valves

Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.6 PIPING ACCESSORIES

2.6.1 Filter Driers

Driers shall conform to ARI 710. Sizes 15 mm (5/8 inch) and larger shall be the full flow, replaceable core type. Sizes 15 mm (1/2 inch) and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 10.3 MPa (1.500 psi) .

2.6.2 Sight Glass and Liquid Level Indicator

2.6.2.1 Assembly and Components

Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

2.6.2.2 Gauge Glass

Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.6.2.3 Bull's-Eye and Inline Sight Glass Reflex Lens

Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

2.6.2.4 Moisture Indicator

Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

2.6.3 Vibration Dampeners

Dampeners shall be of the all-metallic bellows and woven-wire type.

2.6.4 Flexible Pipe Connectors

Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 150 degrees C (300 degrees F) . Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

2.6.5 Strainers

Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.6.6 Pressure and Vacuum Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.6.7 Temperature Gauges

Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Celsius scale in 1 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 1.5 m of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 1.5 to 2.1 m above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 2.1 m above the finished floor.

2.6.7.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 229 mm (9 inches) long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.6.7.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 89 mm (3-1/2 inches), stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

#### 2.6.7.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 89 mm (3-1/2 inches), stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

#### 2.6.7.4 Thermal Well

Thermal well shall be identical size, 15 or 20 mm (1/2 or 3/4 inch) NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 15 mm (1/2 inch) NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 25 mm .

### 2.6.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

### 2.6.9 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

## 2.7 FABRICATION

### 2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

### 2.7.2 Factory Applied Insulation

Refrigerant suction lines between the cooler and each compressor shall be insulated with not less than 19 mm (3/4 inch) thick unicellular plastic foam. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

## 2.8 SUPPLEMENTAL COMPONENTS/SERVICES

### 2.8.1 Field Applied Insulation

Field applied insulation shall be provided and installed in accordance with Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

### 3.1.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

### 3.1.2 Functional Requirements

Piping shall be installed 4 mm per m of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

### 3.1.3 Fittings and End Connections

### 3.1.3.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

### 3.1.3.2 Brazed Connections

Brazing shall be performed in accordance with AWS Brazing Hdbk, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

### 3.1.3.3 Welded Connections

Welded joints in steel refrigerant piping shall be fusion-welded. Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

### 3.1.3.4 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

### 3.1.3.5 Flanged Connections

When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for use with the refrigerants to be handled.

### 3.1.4 Valves

3.1.4.1 General

Refrigerant stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated noncondensible gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

3.1.4.2 Expansion Valves

Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 54 mm (2-1/8 inches) in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 54 mm (2-1/8 inches). The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

3.1.4.3 Valve Identification

Each system valve, including those which are part of a factory assembly, shall be tagged. Tags shall be in alphanumeric sequence, progressing in direction of fluid flow. Tags shall be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 34 mm (1-3/8 inch) diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Tags shall be attached with nonferrous, heavy duty, bead or link chain, 14 gauge annealed wire, nylon cable bands or as approved. Tag numbers shall be referenced in Operation and Maintenance Manuals and system diagrams.

3.1.5 Vibration Dampers

Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.1.6 Strainers

Strainers shall be provided immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

3.1.7 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.8 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

3.1.9 Discharge Line Oil Separator

Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

3.1.10 Accumulator

Accumulators shall be provided in the suction line to each compressor.

3.1.11 Flexible Pipe Connectors

Connectors shall be installed perpendicular to line of motion being isolated. Piping for equipment with bidirectional motion shall be fitted with two flexible connectors, in perpendicular planes. Reinforced elastomer flexible connectors shall be installed in accordance with manufacturer's instructions. Piping guides and restraints related to flexible connectors shall be provided as required.

3.1.12 Temperature Gauges

Temperature gauges shall be located specifically on, but not limited to the following: the sensing element of each automatic temperature control device where a thermometer is not an integral part thereof the liquid line leaving a receiver and the suction line at each evaporator or liquid cooler. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 25 mm .

3.1.13 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.13.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.13.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.13.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.13.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.13.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 100 mm (4 inches) and larger when the temperature of the medium is 16 degrees C or higher. Type 40 shields shall be used on all piping less than 100 mm (4 inches) and all piping 100 mm (4 inches) and larger carrying medium less than 16 degrees C . A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 50 mm (2 inches) and larger.

3.1.13.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 23 kg shall have the excess hanger loads suspended from panel points.

3.1.13.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m, not more than 2.4 m from end of risers, and at vent terminations.

3.1.13.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.13.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger, a Type 39 saddle shall be used. On piping under 100 mm (4 inches), a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.13.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm, or by an amount adequate for the insulation, whichever is greater.

3.1.13.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.13.12 Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections {AM#0001}______________15070{AM#0001}_ SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05120A STRUCTURAL STEEL.

3.1.13.13 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05120A STRUCTURAL STEEL.

3.1.14 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m on each side of each expansion joint, and in lines 100 mm (4 inches) or smaller not more than 600 mm on each side of the joint.

3.1.15 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.1.16 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 1.0 mm (20 gauge) . Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53/A 53M, Schedule 30. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 13 mm depth. Sleeves shall not be installed in structural members.

3.1.16.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 6.35 mm all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07900A JOINT SEALING.

3.1.16.2 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a 5.17 kg/sq. m. (17 ounce) copper sleeve, or a 0.81 mm (0.032 inch) thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 200 mm from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 50 mm above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 250 mm in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.16.3 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07840A FIRESTOPPING.

3.1.16.4 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.17 Access Panels

Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500A MISCELLANEOUS METAL.

3.1.18 Field Applied Insulation

Field installed insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.19 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

3.1.19.1 Color Coding

Color coding for piping identification is specified in Section {AM#0001} 15075 {AM#0001} IDENTIFICATION OF PIPING.

3.1.19.2 Color Coding Scheme

A color coding scheme for locating hidden piping shall be in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

3.2 CLEANING AND ADJUSTING

Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government as determined by the Contracting Officer. Water shall not be used in any procedure or test.

3.3 REFRIGERANT PIPING TESTS

After all components of the refrigerant system have been installed and connected, the entire refrigeration system shall be subjected to pneumatic, evacuation, and startup tests as described herein. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.3.1 Preliminary Procedures

Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

3.3.2 Pneumatic Test

Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 55 degrees C (minus 70 degree F) dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 69 kPa (10 psi) with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 with a maximum test pressure 25 percent greater. Pressure above 690 KPa (100 psig) shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 2 kPa (0.3 psi) will be allowed for each degree C (F) change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

3.3.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 2 degrees C . No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.3.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

3.3.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

### 3.3.6 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 85 g (3 ounces) of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

## 3.4 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

SECTION 15190

GAS PIPING SYSTEMS
**02/99**
**AMENDMENT NO. 0001**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| {AM#0001}ANSI B109.2 | {AM#0001}(2000) Gas Meter |
| ANSI Z21.45 | (1995) Flexible Connectors of Other Than All-Metal Construction for Gas Appliances |
| ANSI Z21.69 | (1992; Z21.69a) Connectors for Movable Gas Appliances |

AMERICAN PETROLEUM INSTITUTE (API)

| | |
|---|---|
| API Spec 6D | (1994; Supple 1 Jun 1996; Supple 2 Dec 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves) |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM D 2513 | (1999a) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.5 | (1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24 |
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |

| | |
|---|---|
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.33 | (1990) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (Sizes 1/2 through 2) |
| ASME B31.1 | (1998) Power Piping |
| ASME B31.2 | (1968) Fuel Gas Piping |
| ASME B36.10M | (1996) Welded and Seamless Wrought Steel Pipe |
| ASME BPV IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-25 | (1998) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (1993) Pipe Hangers and Supports - Materials, Design and Manufacture |
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 54 | (1999) National Fuel Gas Code |
| NFPA 70 | (2002) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL Gas&Oil Dir | (1999) Gas and Oil Equipment Directory |

1.2 GENERAL REQUIREMENTS

1.2.1 Welding

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified at least 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05090 WELDING, STRUCTURAL.

1.2.2 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Manufacturer's descriptive data and installation instructions shall be submitted for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Valves, flanges and fittings shall be marked in accordance with MSS SP-25.

1.2.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gas Piping System.

Drawings showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of connectors and supports.

SD-03 Product Data

Qualifications.

Qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

SD-6 Test Reports

Testing.
Pressure Tests; G, ED.
Pressure Tests for Liquified Petroleum Gas.
Test With Gas.

Test reports in booklet form tabulating test and measurements performed. The reports shall be dated after award of this contract, shall state the contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

## PART 2 PRODUCTS

### 2.1 PIPE AND FITTINGS

#### 2.1.1 Steel Pipe, Joints, and Fittings

Steel pipe shall conform to ASME B36.10M. Malleable-iron threaded fittings shall conform to ASME B16.3. Steel pipe flanges and flanged fittings including bolts, nuts, and bolt pattern shall be in accordance with ASME B16.5. Wrought steel buttwelding fittings shall conform to ASME B16.9. Socket welding and threaded forged steel fittings shall conform to ASME B16.11.

#### 2.1.2 Thermoplastic Pipe, Tubing, Joints, and Fittings

Thermoplastic pipe, tubing, joints and fittings shall conform to ASTM D 2513.

#### 2.1.3 Sealants for Steel Pipe Threaded Joints

Joint sealing compound shall be listed in UL Gas&Oil Dir, Class 20 or less. Tetrafluoroethylene tape shall conform to UL Gas&Oil Dir.

#### 2.1.4 Identification

Pipe flow markings and metal tags shall be provided as required.

#### 2.1.5 Flange Gaskets

Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm (1/16 inch) thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 316 degrees C (600 degrees F) service. NBR binder shall be used for hydrocarbon service.

#### 2.1.6 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

#### 2.1.7 Escutcheons

Escutcheons shall be chromium-plated steel or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

#### 2.1.8 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing metallic and thermoplastic or fiberglass pipe. Approved transition fittings are those that conform to AGA Manual requirements for transitions fittings.

2.1.9 Insulating Pipe Joints

2.1.9.1 Insulating Joint Material

Insulating joint material shall be provided between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.1.9.2 Threaded Pipe Joints

Joints for threaded pipe shall be steel body nut type dielectric unions with insulating gaskets.

2.1.9.3 Flanged Pipe Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts.

2.1.10 Flexible Connectors

Flexible connectors for connecting gas utilization equipment to building gas piping shall conform to ANSI Z21.45. Flexible connectors for movable food service equipment shall conform to ANSI Z21.69.

2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.2.1 Valves 50 mm and Smaller

Valves 50 mm and smaller shall conform to ASME B16.33 and shall be of materials and manufacture compatible with system materials used.

2.2.2 Valves 65 mm and Larger

Valves 65 mm and larger shall be carbon steel conforming to API Spec 6D, Class 150.

2.3 PIPE HANGERS AND SUPPORTS

Pipe hangers and supports shall conform to MSS SP-58 and MSS SP-69.

2.4 METERS, REGULATORS AND SHUTOFF VALVES

{AM#0001}Meters shall conform to ANSI B109.2. Meters shall be pedestal mounted and be provided with a strainer immediately upstream. Meters shall be provided with over-pressure protection as specified in ASME B31.8. Meters shall be suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Meters shall have a pulse switch initiator capable of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments. Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. It shall provide not less than one pulse per 2.83 cubic meter (100 cubic feet) of gas.

{AM#0001}Pressure regulators for individual service lines shall have ferrous bodies. Regulator shall be capable of reducing distribution line pressure to pressures required for users. Regulators shall be provided where gas will be distributed at pressures in excess of 2.5 kPa (10 inches of water column). Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulators for liquified petroleum gas shall be adjusted to 2.5 to 3 kPa (10 to 12 inches of water column). Regulator shall have single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet. Regulator valve vent shall be of resilient materials designed to withstand flow conditions when pressed against the valve port. Regulator shall be capable of regulating downstream pressure within limits of accuracy and shall be capable of limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Regulator shall have a self contained service regulator. Regulator pipe connections shall not exceed 50 mm (2 inch) size.

# PART 3 EXECUTION

## 3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02316 EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.

## 3.2 GAS PIPING SYSTEM

Gas piping system shall be from the point of delivery, defined as the outlet of the meter set assembly, specified in Section 02556 GAS DISTRIBUTION SYSTEM, to the connections to each gas utilization device.

### 3.2.1 Protection of Materials and Components

Pipe and tube openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage. At the completion of all work, the entire system shall be thoroughly cleaned.

### 3.2.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Defects in piping, tubing or fittings shall not be repaired. When defective piping, tubing, or fittings are located in a system, the defective material shall be replaced.

## 3.3 PROTECTIVE COVERING

### 3.3.1 Underground Metallic Pipe

Buried metallic piping shall be protected from corrosion with protective coatings as specified in Section 02556 GAS DISTRIBUTION SYSTEM. When dissimilar metals are joined underground, gastight insulating fittings shall be used.

### 3.3.2 Aboveground Metallic Piping Systems

#### 3.3.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, loose mill scale and other foreign substances shall be mechanically cleaned by power wire brushing and primed with ferrous metal primer or vinyl type wash coat. Primed surface shall be finished with two coats of exterior oil paint or vinyl paint.

## 3.4 INSTALLATION

Installation of the gas system shall be in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54, AGA Manual, and as indicated. Pipe cutting shall be done without damage to the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 150 mm and larger, an approved gas cutting and beveling machine may be used. Cutting of thermoplastic and fiberglass pipe shall be in accordance with AGA Manual.

### 3.4.1 Metallic Piping Installation

Underground piping shall be buried a minimum of 450 mm below grade. Changes in direction of piping shall be made with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Aluminum alloy pipe shall not be used in exterior locations or underground.

### 3.4.2 Metallic Tubing Installation

Metallic tubing shall be installed using gas tubing fittings approved by the tubing manufacturer. Branch connections shall be made with tees. All tubing end preparation shall be made with tools designed for the purpose. Aluminum alloy tubing shall not be used in exterior locations or underground.

### 3.4.3 Thermoplastic and Fiberglass Piping, Tubing, and Fittings

Thermoplastic and fiberglass piping, tubing, and fittings shall be installed outside and underground only. Piping shall be buried a minimum of 450 mm below grade. The piping shall be installed to avoid excessive stresses due to thermal contraction. Thermoplastic and fiberglass piping shall only be allowed as indicated.

### 3.4.4 Connections Between Metallic and Plastic Piping

Connections shall be made only outside, underground, and with approved transition fittings.

3.4.5 Piping Buried Under Buildings

No gas piping shall be buried under Building.

3.4.6 Concealed Piping in Buildings

When installing piping which is to be concealed, unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints made by combinations of fittings shall not be used.

3.4.6.1 Piping in Partitions

Concealed piping shall be located in hollow rather than solid partitions. Tubing passing through walls or partitions shall be protected against physical damage.

3.4.6.2 Piping in Floors

Piping in solid floors except where embedment in concrete is indicated shall be laid in channels suitably covered to permit access to the piping with minimum damage to the building.

3.4.7 Aboveground Piping

Aboveground piping shall be run as straight as practicable along the alignment indicated and with a minimum of joints. Piping shall be separately supported. Exposed horizontal piping shall not be installed farther than 150 mm from nearest parallel wall in laundry areas where clothes hanging could be attempted.

3.4.8 Final Gas Connections

Unless otherwise specified, final connections shall be made with rigid metallic pipe and fittings. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.5 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

3.5.1 Threaded Metallic Joints

Threaded joints in metallic pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 40 mm in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 50 mm in diameter may be made with approved joint sealing compound. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.

3.5.2 Welded Metallic Joints

Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

3.5.3 Flared Metallic Tubing Joints

Flared joints in metallic tubing shall be made with special tools recommended by the tubing manufacturer. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Metallic ball sleeve compression-type tubing fittings shall not be used for tubing joints.

3.6 PIPE SLEEVES

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. All rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor or roof, and shall be cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Sleeves in mechanical room floors above grade shall extend at least 100 mm above finish floor. Unless otherwise indicated, sleeves shall be large enough to provide a minimum clearance of 6.4 mm all around the pipe. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, the annular space between the pipe and sleeve shall be sealed with firestopping material and sealant that meet the requirement of Section 07840 FIRESTOPPING.

3.7 FIRE SEAL

Penetrations of fire rated partitions, walls and floors shall be in accordance with Section 07840 FIRESTOPPING.

3.8 ESCUTCHEONS

Escutcheons shall be provided for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.9 SPECIAL REQUIREMENTS

Drips, grading of the lines, freeze protection, and branch outlet locations shall be as shown and shall conform to the requirements of NFPA 54.

3.10 BUILDING STRUCTURE

Building structure shall not be weakened by the installation of any gas piping. Beams or joists shall not be cut or notched.

3.11 {AM#0001}METER INSTALLATIONS

Meters shall be installed in accordance with ASME B31.8. Permanent gas meters shall be installed with provisions for isolation and removal for calibration and maintenance, and shall be suitable for operation in conjunction with an energy monitoring and control system.

3.12 PIPING SYSTEM SUPPORTS

Gas piping systems in buildings shall be supported with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Gas piping system shall not be supported by other piping. Spacing of supports in gas piping and tubing installations shall conform to the requirements of NFPA 54. The selection and application of supports in gas piping and tubing installations shall conform to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 3.2 mm shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.13 ELECTRICAL BONDING AND GROUNDING

The gas piping system within the building shall be electrically continuous and bonded to a grounding electrode as required by NFPA 70. Conventional flange joints allow sufficient current flow to satisfy this requirement.

3.14 SHUTOFF VALVE

Main gas shutoff valve controlling the gas piping system shall be easily accessible for operation and shall be installed as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

3.15 CATHODIC PROTECTION

Cathodic protection shall be provided for underground ferrous gas piping as specified in Section 13110 CATHODIC PROTECTION SYSTEM SACRIFICIAL ANODE.

3.16 TESTING

Before any section of a gas piping system is put into service, it shall be carefully tested to assure that it is gastight. Prior to testing, the system shall be blown out, cleaned and cleared of all foreign material. Each joint shall be tested by means of an approved gas detector, soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed, or concealed. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Oxygen shall not be used as a testing medium.

3.16.1 Pressure Tests

Before appliances are connected, piping systems shall be filled with air or an inert gas and shall withstand a minimum pressure of 21 kPa gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device so calibrated as to be read in increments of not greater than 1 kPa. The source of pressure shall be isolated before the pressure tests are made.

3.16.2 Test With Gas

Before turning gas under pressure into any piping, all openings from which gas can escape shall be closed. Immediately after turning on the gas, the piping system shall be checked for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. All testing shall conform to the requirements of NFPA 54. If leakage is recorded, the gas supply shall be shut off, the leak shall be repaired, and the tests repeated until all leaks have been stopped.

3.16.3 Purging

After testing is completed, and before connecting any appliances, all gas piping shall be fully purged. LPG piping tested using fuel gas with appliances connected does not require purging. Piping shall not be purged into the combustion chamber of an appliance. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.

3.16.4 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

3.17 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section {AM#0001} 15075 {AM#0001} IDENTIFICATION OF PIPING.

-- End of Section --

# SECTION 15400

# PLUMBING, GENERAL PURPOSE
**01/02**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

| | |
|---|---|
| ARI 1010 | (1994) Self-Contained, Mechanically Refrigerated Drinking-Water Coolers |
| ARI 700 | (1999) Specifications for Fluorocarbon and Other Refrigerants |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.10.1 | (1998; Z21.10.1a; Z21.10.1b; Z21.10.1c) Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less |
| ANSI Z21.10.3 | (1998) Gas Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous Water Heaters |
| ANSI Z21.22 | (1999) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems |
| ANSI Z358.1 | (1998) Emergency Eyewash and Shower Equipment |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 105/A 105M | (2001) Carbon Steel Forgings for Piping Applications |
| ASTM A 183 | (1998) Carbon Steel Track Bolts and Nuts |
| ASTM A 193/A 193M | (2001a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |

| | |
|---|---|
| ASTM A 47/A 47M | (1999) Ferritic Malleable Iron Castings |
| ASTM A 515/A 515M | (1989; R 1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service |
| ASTM A 516/A 516M | (1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 536 | (1984; R 1999el) Ductile Iron Castings |
| ASTM A 733 | (1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples |
| ASTM A 74 | (1998) Cast Iron Soil Pipe and Fittings |
| ASTM A 888 | (1998el) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| ASTM B 152 | (1997a) Copper Sheet, Strip, Plate, and Rolled Bar |
| ASTM B 152M | (1997a) Copper Sheet, Strip, Plate, and Rolled Bar (Metric) |
| ASTM B 306 | (1999) Copper Drainage Tube (DWV) |
| ASTM B 32 | (1996) Solder Metal |
| ASTM B 370 | (1998) Copper Sheet and Strip for Building Construction |
| ASTM B 42 | (1998) Seamless Copper Pipe, Standard Sizes |
| ASTM B 43 | (1998) Seamless Red Brass Pipe, Standard Sizes |
| ASTM B 584 | (2000a) Copper Alloy Sand Castings for General Applications |
| ASTM B 75 | (1999) Seamless Copper Tube |
| ASTM B 813 | (2000) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube |
| ASTM B 828 | (2000) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube |

| | |
|---|---|
| | and Fittings |
| ASTM B 88 | (1999) Seamless Copper Water Tube |
| ASTM B 88M | (1999) Seamless Copper Water Tube (Metric) |
| ASTM C 564 | (1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings |
| ASTM C 920 | (1998) Elastomeric Joint Sealants |
| ASTM D 2000 | (1999) Rubber Products in Automotive Applications |
| ASTM D 2235 | (1996a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings |
| ASTM D 2564 | (1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D 2657 | (1997) Heat Fusion Joining Polyolefin Pipe and Fittings |
| ASTM D 2822 | (1991; R 1997el) Asphalt Roof Cement |
| ASTM D 2855 | (1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings |
| ASTM D 3122 | (1995) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings |
| ASTM D 3138 | (1995) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components |
| ASTM D 3139 | (1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals |
| ASTM D 3212 | (1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals |
| ASTM D 3308 | (1997) PTFE Resin Skived Tape |
| ASTM D 3311 | (1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns |
| ASTM E 1 | (1998) ASTM Thermometers |
| ASTM F 1290 | (1998a) Electrofusion Joining Polyolefin |

| | |
|---|---|
| | Pipe and Fittings |
| ASTM F 409 | (1999a) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings |
| ASTM F 477 | (1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F 493 | (1997) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 34 | (1997) Number Designation and Safety Classification of Refrigerants |
| ASHRAE 90.1 | (1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i: 90.1l-1995; 90.1m-1995; 90.1n-1997) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings |

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

| | |
|---|---|
| ASSE 1001 | (1990) Pipe Applied Atmospheric Type Vacuum Breakers |
| ASSE 1003 | (1995) Water Pressure Reducing Valves for Domestic Water Supply Systems |
| ASSE 1005 | (1986) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size |
| ASSE 1011 | (1995) Hose Connection Vacuum Breakers |
| ASSE 1012 | (1995) Backflow Preventers with Intermediate Atmospheric Vent |
| ASSE 1013 | (1999) Reduced Pressure Principle Backflow Preventers |
| ASSE 1018 | (1986) Trap Seal Primer Valves Water Supply Fed |
| ASSE 1020 | (1998) Pressure Vacuum Breaker Assembly (Recommended for Outdoor Usage) |
| ASSE 1037 | (1990; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures |

AMERICAN WATER WORKS ASSOCIATION(AWWA)

| | |
|---|---|
| AWWA B300 | (1999) Hypochlorites |
| AWWA B301 | (1992; Addenda B301a - 1999) Liquid Chlorine |
| AWWA C105 | (1999) Polyethylene Encasement for Ductile-Iron Pipe Systems |
| AWWA C203 | (1997; Addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied |
| AWWA C606 | (1997) Grooved and Shouldered Joints |
| AWWA C700 | (1995) Cold-Water Meters - Displacement Type, Bronze Main Case |
| AWWA C701 | (1988) Cold-Water Meters - Turbine Type, for Customer Service |
| AWWA EWW | (1999) Standard Methods for the Examination of Water and Wastewater |
| AWWA M20 | (1973) Manual: Water Chlorination Principles and Practices |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8 | (1992) Filler Metals for Brazing and Braze Welding |
| AWS B2.2 | (1991) Brazing Procedure and Performance Qualification |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME A112.1.2 | (1991; R 1998) Air Gaps in Plumbing Systems |
| ASME A112.19.1M | (1994; R 1999 Enameled Cast Iron Plumbing Fixtures |
| ASME A112.19.2M | (1998) Vitreous China Plumbing Fixtures |
| ASME A112.19.3M | (1987; R 1996) Stainless Steel Plumbing Fixtures (Designed for Residential Use |
| ASME A112.21.1M | (1991; R 1998) Floor Drains |
| ASME A112.36.2M | (1991; R 1998) Cleanouts |
| ASME A112.6.1M | (1997) Supports for Off-the-Floor Plumbing Fixtures for Public Use |

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.12 | (1998) Cast Iron Threaded Drainage Fittings |
| ASME B16.15 | (1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250 |
| ASME B16.18 | (1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.22 | (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.23 | (1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV |
| ASME B16.24 | (1991; R 1998) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300 |
| ASME B16.29 | (1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV |
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.34 | (1997) Valves - Flanged, Threaded, and Welding End |
| ASME B16.39 | (1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300 |
| ASME B16.4 | (1998) Gray Iron Threaded Fittings |
| ASME B16.5 | (1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24 |
| ASME B31.1 | (1998) Power Piping |
| ASME B31.5 | (1992; B31.5a1994) Refrigeration Piping |
| ASME B40.1 | (1991) Gauges - Pressure Indicating Dial Type - Elastic Element |
| ASME BPVC SEC VIII D1 | (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage |

| | |
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| ASME CSD-1 | (1998) Controls and Safety Devices for Automatically Fired Boilers |

CAST IRON SOIL PIPE INSTITUTE (CISPI)

| | |
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| CISPI 301 | (1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| CISPI 310 | (1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| CISPI HSN-85 | (1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings |

COPPER DEVELOPMENT ASSOCIATION (CDA)

| | |
|---|---|
| CDA Tube Handbook | (1995) Copper Tube Handbook |

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

| | |
|---|---|
| FCCCHR-CCC | (1993) Manual of Cross-Connection Control |

HYDRAULIC INSTITUTE (HI)

| | |
|---|---|
| HI 1.1-1.5 | (1994) Centrifugal Pumps |

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

| | |
|---|---|
| IAPMO Z124.9 | (1994) Plastic Urinal Fixtures |

INTERNATIONAL CODE COUNCIL (ICC)

| | |
|---|---|
| CABO A117.1 | (1998) Accessible and Usable Buildings and Facilities |
| ICC Plumbing Code | (2000)International Plumbing Code (IPA) |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-110 | (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |
| MSS SP-25 | (1998) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-44 | (1996) Steel Pipe line Flanges |

| | |
|---|---|
| MSS SP-58 | (1993) Pipe Hangers and Supports - Materials, Design and Manufacture |
| MSS SP-67 | (1995) Butterfly Valves |
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |
| MSS SP-70 | (1998) Cast Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-71 | (1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends |
| MSS SP-72 | (1999) Ball Valves with Flanged or Butt-Welding Ends for General Service |
| MSS SP-73 | (1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings |
| MSS SP-78 | (1998) Cast Iron Plug Valves, Flanged and Threaded Ends |
| MSS SP-80 | (1997) Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-83 | (1995) Class 3000 Steel Pipe Unions Socket-Welding and Threaded |
| MSS SP-85 | (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (1997) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 31 | (1997; TIA 97-1) Installation of Oil Burning Equipment |
| NFPA 54 | (1999) National Fuel Gas Code |
| NFPA 90A | (1999) Installation of Air Conditioning and Ventilating Systems |

NSF INTERNATIONAL (NSF)

| | |
|---|---|
| NSF 14 | (1999) Plastics Piping Components and Related Materials |
| NSF 61 | (1999) Drinking Water System Components - |

| | |
|---|---|
| | Health Effects (Sections 1-9) |

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

| | |
|---|---|
| PPFA-01 | (1998) Plastic Pipe in Fire Resistive Construction |

PLUMBING AND DRAINAGE INSTITUTE (PDI)

| | |
|---|---|
| PDI WH 201 | (1992) Water Hammer Arresters |

PLUMBING-HEATING-COOLING CONTRACTORS NATIONAL ASSOCIATION (NAPHCC)

| | |
|---|---|
| NAPHCC Plumbing Code | (1996) National Standard Plumbing Code |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE J 1508 | (1997) Hose Clamps |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 10 CFR 430 | Energy Conservation Program for Consumer Products |
| PL 93-523 | (1974; Amended 1986) Safe Drinking Water Act |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 430 | (1994; Rev thru Nov 1996) Waste Disposers |

## 1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

## 1.3 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System; G, AE.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

Electrical Schematics; G, AE.

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

SD-03 Product Data

Welding; G, RE.

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Plumbing Fixture Schedule; G, AE.

Catalog cuts of specified plumbing fixtures valves related piping system and system location where installed.

Vibration-Absorbing Features; G, AE.

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

Plumbing System; G, RE.

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

SD-06 Test Reports

Tests, Flushing and Disinfection; G, RE.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Backflow Prevention Assembly Tests; G, RE..

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

SD-07 Certificates

Materials and Equipment; G, RE.

Where materials or equipment are specified to comply with requirements of AGA, ASME, or NSF proof of such compliance shall be included. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts.

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

SD-10 Operation and Maintenance Data

Plumbing System; G, RE.

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Sixcopies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

## 1.5 PERFORMANCE REQUIREMENTS

### 1.5.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record. Structural members shall be welded in accordance with Section 05090A WELDING, STRUCTURAL.

### 1.5.2 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with Section 13110A CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE).

## 1.6 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with ICC Plumbing Code.

## 1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

# PART 2 PRODUCTS

## 2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310

b. Coupling for Steel Pipe: AWWA C606.

c. Couplings for Grooved Pipe: Ductile Iron ASTM A 536 (Grade 65-45-12).

d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1.6 mm (1/16 inch) thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

e. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.

f. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.

g. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

h. Solder Material: Solder metal shall conform to ASTM B 32.

i. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

j. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.

k. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.

l. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 110 degrees C (230 degrees F).

m. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.

n. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A 183.

o. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.

p. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D 2235.

q. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.

r. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493.

s. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

t. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D 3122.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201.

b. Copper, Sheet and Strip for Building Construction: ASTM B 370.

c. Asphalt Roof Cement: ASTM D 2822.

d. Hose Clamps: SAE J 1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines:

AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

l. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.

m. Thermometers: ASTM E 1. Mercury shall not be used in thermometers.

### 2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

## 2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 65 mm (2-1/2 inches) and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm (3 inches) and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

| Description | Standard |
|---|---|
| Butterfly Valves | MSS SP-67 |
| Cast-Iron Gate Valves, Flanged and Threaded Ends | MSS SP-70 |
| Cast-Iron Swing Check Valves, Flanged and Threaded Ends | MSS SP-71 |
| Ball Valves with Flanged Butt-Welding Ends for General Service | MSS SP-72 |
| Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends | MSS SP-110 |
| Cast-Iron Plug Valves, Flanged and Threaded Ends | MSS SP-78 |
| Bronze Gate, Globe, Angle, and Check Valves | MSS SP-80 |
| Steel Valves, Socket Welding and Threaded Ends | ASME B16.34 |
| Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends | MSS SP-85 |

| Description | Standard |
|---|---|
| Vacuum Relief Valves | ANSI Z21.22 |
| Water Pressure Reducing Valves | ASSE 1003 |
| Water Heater Drain Valves | ASSE 1005 |
| Trap Seal Primer Valves | ASSE 1018 |
| Temperature and Pressure Relief Valves for Hot Water Supply Systems | ANSI Z21.22 |
| Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers | ASME CSD-1<br>Safety Code No., Part CW, Article 5 |

2.3.1 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 20 mm (3/4 inch) male inlet threads, hexagon shoulder, and 20 mm (3/4 inch) hose connection. Faucet handle shall be securely attached to stem.

2.3.2 Wall Hydrants

Wall hydrants with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 20 mm (3/4 inch) exposed hose thread on spout and 20 mm (3/4 inch) male pipe thread on inlet.

2.3.3 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 59 kW (200,000 Btuh) shall have 20 mm (3/4 inch) minimum inlets, and 20 mm (3/4 inch) outlets. Relief valves for systems where the maximum rate of heat input is greater than 59 kW (200,000 Btuh) shall have 25 mm (1 inch) minimum inlets, and 25 mm (1 inch) outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

### 2.3.4 Thermostatic Mixing Valves

Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 2 degrees C of any setting.

## 2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with ICC Plumbing Code. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 82 degrees C (180 degrees F) water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

### 2.4.1 Lavatories

Vitreous china lavatories shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

## 2.5 BACKFLOW PREVENTERS

Backflow preventers shall be approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR-CCC. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

## 2.6 DRAINS

### 2.6.1 Floor and Shower Drains{AM#0001}, FD-1

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M.

### 2.6.2 Floor Sinks{AM#0001}, FS-1

Floor sinks shall be square, with 300 mm (12 inch) nominal overall width or diameter and 250 mm (10 inch) nominal overall depth. Floor sink shall have an acid-resistant enamel interior finish with cast-iron body, aluminum sediment bucket, and perforated grate of cast iron in industrial areas and stainless steel in finished areas. The outlet pipe size shall be as indicated or of the same size as the connecting pipe.

### 2.6.3 Boiler Room Drains{AM#0001}, FD-2

Boiler room drains shall have combined drain and trap, hinged grate, removable bucket, and threaded brass cleanout with brass backwater valve. The removable galvanized cast-iron sediment bucket shall have rounded corners to eliminate fouling and shall be equipped with hand grips. Drain shall have a minimum water seal of 100 mm (4 inches). The grate area shall be not less than 0.065 square meters (100 square inches).

## 2.7 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.813 mm (0.032 inch) thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 50 mm (2 inches). The interior diameter shall be not more than 3.2 mm (1/8 inch) over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

## 2.8 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 32 to 71 degrees C (90 to 160 degrees F). Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 49 to 82 degrees C (120 to 180 degrees F). Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 2000 liters storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

### 2.8.1 Automatic Storage Type

#### 2.8.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 22 KW (75,000 BTU per hour) or less or ANSI Z21.10.3 for heaters with input greater than 22 KW (75,000 BTU per hour). A phenolic resin coating shall be provided.

## 2.9 PUMPS

### 2.9.1 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump capacities, efficiencies, motor sizes, speeds, and impeller types shall be as shown. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze. Motor shall be totally enclosed, fan-cooled and shall have sufficient wattage (horsepower) for the service required. Pump shall conform to HI 1.1-1.5. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with

"START-STOP" switch in cover. Pump motors smaller than 746 W (Fractional horsepower pump motors) shall have integral thermal overload protection in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

2.9.2 Booster Pumps

2.9.2.1 Centrifugal Pumps

Horizontal split-case centrifugal-type booster pumps shall be furnished. The capacities shall be as shown, and the speed shall not exceed 1800 rpm. Pumps shall have a casing of close-grained iron or steel with smooth water passages. A gasket shall be provided between the upper and lower halves of the casing. Suction and discharge connections shall be flanged. Impellers shall be nonoverloading, bronze, balanced to eliminate vibration, and shall be keyed to corrosion-resisting steel shafts. The casings shall be fitted with bronze wearing or sealing rings. Bearings shall be cartridge type, enabling the entire rotating element to be removed without disturbing alignment or exposing the bearings to dirt, water, and other foreign matter. Pumps shall be provided with mechanical seals. Seal boxes shall be machined in the pump casing and at both sides of the pump, and shall be of sufficient depth to include a conventional bronze seal ring and rows of shaft packing. Bedplates shall be close-grain cast iron or steel with ribs and lugs, complete with foundation bolts, and shall have a drip lip with drain hole. Each pump shall be tested at the manufacturer's plant for operating characteristics at the rated capacity and under specified operating conditions. Test curves shall be furnished showing capacity in liters per second (gpm), head in meters (feet), efficiency, brake wattage (horsepower), and operation in parallel with similar pumps. Multiple pump installations shall have pump characteristics compatible for operation in parallel with similar pumps. The electric motor shall be sized for non-overload when operating at any point along the characteristic curve of the pump. Guards shall shield exposed belts and moving parts.

2.9.2.2 Controls

Each pump motor shall be provided with enclosed across-the-line-type magnetic controller complete in a NEMA 250 Type 1 enclosure with three position, "HAND-OFF-AUTOMATIC," selector switch in cover. Pumps shall be automatically started and stopped by float or pressure switches, as indicated. The pumps shall start and stop at the levels and pressures indicated. A multiposition sequence selector switch shall be provided so that any two pumps may be operated simultaneously beeping a third pump as a standby.

2.9.3 Flexible Connectors

Flexible connectors shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

2.10 {AM#0001}DELETED

## 2.11 COMPRESSED AIR SYSTEM

### 2.11.1 Air Compressors

Air compressor unit shall be a factory-packaged assembly, including single phase, 120 volt motor controls, switches, wiring, accessories, and motor controllers, in a NEMA 250, Type 4 enclosure. Tank-mounted air compressors shall be manufactured to comply with UL listing requirements. Air compressors shall have manufacturer's name and address, together with trade name, and catalog number on a nameplate securely attached to the equipment. Each compressor shall start and stop automatically at upper and lower pressure limits of the system. Guards shall shield exposed moving parts. {AM#0001}______________Each compressor motor shall be provided with an across-the-line-type magnetic controller, complete with low-voltage release. An intake air filter and silencer shall be provided with each compressor. Aftercooler and moisture separator shall be installed between compressors and air receiver to remove moisture and oil condensate before the air enters the receiver. Aftercoolers shall be either air- or water-cooled, as indicated. The air shall pass through a sufficient number of tubes to affect cooling. Tubes shall be sized to give maximum heat transfer. Water to unit shall be controlled by a solenoid or pneumatic valve, which opens when the compressors start and closes when the compressors shut down. Cooling capacity of the aftercooler shall be sized for the total capacity of the compressors. Means shall be provided for draining condensed moisture from the receiver by an automatic float type trap. Capacities of air compressors and receivers shall be as indicated.

### 2.11.2 Lubricated Compressors

Compressors shall be two-stage, V-belt drive, capable of operating continuously against their designed discharge pressure, and shall operate at a speed not in excess of 1800 rpm. Compressors shall have the capacity and discharge pressure indicated. Compressors shall be assembled complete on a common subbase. The compressor main bearings shall be either roller or ball. The discharge passage of the high pressure air shall be piped to the air receiver with a copper pipe or tubing. A pressure gauge calibrated to 1.03 MPa (150 psi) and equipped with a gauge cock and pulsation dampener shall be furnished for installation adjacent to pressure switches.

### 2.11.3 Air Receivers

Receivers shall be designed for 1.38 MPa (200 psi) working pressure. Receivers shall be factory air tested to 1-1/2 times the working pressure. Receivers shall be equipped with safety relief valves and accessories, including pressure gauges and automatic and manual drains. The outside of air receivers may be galvanized or supplied with commercial enamel finish. Receivers shall be designed and constructed in accordance with ASME BPVC SEC VIII D1 and shall have the design working pressures specified herein. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code shall be provided.

### 2.11.4 Intake Air Supply Filter

Dry type air filter shall be provided having a collection efficiency of 99 percent of particles larger than 10 microns. Filter body and media shall withstand a maximum 862 kPa (125 psi), capacity as indicated.

#### 2.11.5 Pressure Regulators

The air system shall be provided with the necessary regulator valves to maintain the desired pressure for the installed equipment. Regulators shall be designed for a maximum inlet pressure of 862 kPa (125 psi) and a maximum temperature of 93 degrees C (200 degrees F). Regulators shall be single-seated, pilot-operated with valve plug, bronze body and trim or equal, and threaded connections. The regulator valve shall include a pressure gauge and shall be provided with an adjustment screw for adjusting the pressure differential from 0 kPa to 862 kPa (0 to 125 psi). Regulator shall be sized as indicated.

### 2.12 DOMESTIC WATER SERVICE METER

Cold water meters 50 mm and smaller shall be positive displacement type conforming to AWWA C700. Cold water meters 64 mm and larger shall be turbine type conforming to AWWA C701. Meter register may be round or straight reading type, indicating gallons . Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenums. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 1.5 m outside the building, unless otherwise indicated. An OS&Y gate valve and drain shall be installed on the water service line inside the building approximately 150 mm above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 300 mm below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

#### 3.1.1 Water Pipe, Fittings, and Connections

##### 3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 12 mm between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 20 mm (3/4 inch) hose bibb with renewable seat and ball valve ahead of hose bibb. At other low points, 20 mm (3/4 inch) brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 15 m in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 100 mm in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

3.1.2 Compressed Air Piping (Non-Oil Free)

Compressed air piping shall be installed as specified for water piping and suitable for 862 kPa (125 psig) working pressure. Compressed air piping shall have supply lines and discharge terminals legibly and permanently marked at both ends with the name of the system and the direction of flow.

### 3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

#### 3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

#### 3.1.3.2 Mechanical Couplings

Grooved mechanical joints shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of the pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.1.3.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 65 mm (2-1/2 inches) and smaller; flanges shall be used on pipe sizes 80 mm (3 inches) and larger.

#### 3.1.3.4 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

#### 3.1.3.5 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.3.6 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections.

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 50 mm (2 inches) and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.

c. Copper Tube Extracted Joint. An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC Plumbing Code using B-cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

3.1.3.7 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.3.8 Corrosive Waste Plastic Pipe

Joints for polyolefin pipe and fittings shall be made by mechanical joint or electrical fusion coil method in accordance with ASTM D 2657 and ASTM F 1290. Joints for filament-wound reinforced thermosetting resin pipe shall be made in accordance with manufacturer's instructions. Unions or flanges shall be used where required for disconnection and inspection.

3.1.3.9 Other Joint Methods

3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.5 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.5.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for supply, drainage, waste and vent pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 100 mm above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 6 mm (1/4 inch) clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900A JOINT SEALING. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 12 mm (1/2 inch) from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and [concrete] [masonry] wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07840A FIRESTOPPING.

3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a 4.9 kg per square meter (16 ounce) copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 200 mm from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 250 mm. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 200 mm from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 250 mm (10 inches) in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.5.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 40 mm to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 40 mm; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 200 mm from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 40 mm to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.5.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 150 mm (6 inches) in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.1.5.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 6 to 13 mm wide by 6 to 10 mm deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07900A JOINT SEALING.

3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840A FIRESTOPPING.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Sections {AM#0001}___________15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05120A STRUCTURAL STEEL.

3.1.7.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 100 mm (4 inches).

(2) Be used on insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or less.

(3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 128 kg per cubic meter (8 pcf) or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 49 degrees C for PVC and 82 degrees C for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 4.5 m nor more than 2 m from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 100 mm (4 inches) a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 100 mm (4 inches) and larger carrying medium less that 15 degrees C a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

### 3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

### 3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm (4 inches) will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 100 mm (4 inches). Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 450 mm of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

## 3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

### 3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 150 mm above the top of the tank or water heater.

### 3.2.2 Installation of Gas- and Oil-Fired Water Heater

Installation shall conform to NFPA 54 for gas fired and NFPA 31 for oil fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 600 mm just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

### 3.2.3 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

## 3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

### 3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

### 3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 1 m above the floor, except at water closets intended for use by the physically handicapped where flushometer valves shall be mounted at approximately 760 mm above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure.

### 3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 775 mm above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 1020 mm above floor. Wall-hung service sinks shall be mounted with rim 700 mm above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with CABO A117.1.

### 3.3.4 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.4.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab.

3.3.4.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab.

3.3.4.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall not be used.

3.3.4.4 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.3.5 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with ICC Plumbing Code at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.6 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05500A MISCELLANEOUS METAL.

3.3.7 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 50 mm above the flood rim of the funnel to provide an acceptable air gap.

#### 3.3.8 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

## 3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration to 10 percent of the lowest equipment rpm.

### 3.4.1 Tank- or Skid-Mounted Compressors

Floor attachment shall be as recommended by compressor manufacturer. Compressors shall be mounted to resist seismic loads as specified in Section 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

### 3.4.2 Foundation-Mounted Compressors

Foundation attachment shall be as recommended by the compressor manufacturer. Compressors shall be mounted to resist seismic loads as specified in Section 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

## 3.5 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer.

## 3.6 IDENTIFICATION SYSTEMS

### 3.6.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 35 mm (1-3/8 inch) minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

### 3.6.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section {AM#0001}

__________ {AM#0001}______MECHANICAL IDENTIFICATION.

3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

3.9 TESTS, FLUSHING AND DISINFECTION

3.9.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC Plumbing Code.

a. Drainage and Vent Systems Test. The final test shall include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.9.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:

| | |
|---|---|
| Data on Device | Data on Testing Firm |
| Type of Assembly | Name |
| Manufacturer | Address |
| Model Number | Certified Tester |
| Serial Number | Certified Tester No. |
| Size | Date of Test |
| Location | |
| Test Pressure Readings | Serial Number and Test Data of Gauges |

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.9.1.2 Compressed Air Piping (Nonoil-Free)

Piping systems shall be filled with oil-free dry air or gaseous nitrogen to 1.03 MPa and hold this pressure for 2 hours with no drop in pressure.

3.9.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.9.3 System Flushing

3.9.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 1.2 meters per second (4 fps) through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration.

3.9.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation. All faucets and drinking water fountains, to include any device considered as an end point device by NSF 61, Section 9, shall be flushed a minimum of 1 L per 24 hour period, ten times over a 14 day period.

3.9.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of each domestic hot-water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

### 3.9.5 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.9.6 Flushing of Potable Water System

As an option to the system flushing specified above, the potable water system system shall be flushed and conditioned until the residual level of lead is less than that specified by the base industrial hygienist. The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.10 PLUMBING FIXTURE SCHEDULE

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, wall mounted. Flange shall be copper alloy or cast iron.

Gasket shall be wax type.

Seat - IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush.

P-2 WATER CLOSET HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features are the same as P-1.

P-3 WATER CLOSET:

Blowout, elongated bowl, top supply spud, 14 gage, 504 stainless steel seamless, welded wall mounted. Flange shall be copper alloy or cast iron.

Gasket shall be wax type.

Seat - IAPMO Z124.5, Type A, black plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush.

{AM#0001}P-3A WATER CLOSET:

{AM#0001}Same as P-3, except mounted in accordance with CABO A117.1.

P-4 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M washout. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 3.8 liters per flush.

P-5 URINAL:

Sames as P-4 except mounted at 430 mm.

P-6 URINAL:

Wall hanging, with integral trap 14 gage stainless steel seamless welded washout. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 3.8 liters per flush.

{AM#0001}P-6A URINAL:

{AM#0001}Same as P-6, except mounted at 430 mm.

P-7 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M, countertop.

Faucet - Faucets shall meet the requirements of NSF 61, Section 9. Faucets shall be single control, mixing type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel. See paragraph FIXTURES for optional plastic accessories.

P-7A WHEELCHAIR LAVATORY:

Vitreous china, same as P-7 with wrist or elbow controls with gooseneck spout. The flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

Drain - Strainer shall be copper alloy or stainless steel insulation kit shall be provided on waste and supply piping.

P-8 KITCHEN SINK:

Ledge back with holes for faucet and spout double bowl 1067.0 x 533.4 mm (42 x 21 inches) stainless steel ASME A112.19.3M.

Faucet and Spout - Faucets shall meet the requirements of NSF 61, Section 9. Cast or wrought copper alloy. Aerator shall have internal threads. T he flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Single lever type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P-9 DOUBLE COMPARTMENT DEEP SINK:

Ledge back with holes for faucet and spout double bowl 1067.0 x 533.4 mm x 355 mm deep (42 x 21 x 14 inches deep) stainless steel ASME A112.19.3M.

Faucet and Spout - Faucets shall meet the requirements of NSF 61, Section 9. Cast or wrought copper alloy. Aerator shall have internal threads. The flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Gooseneck with wrist baldes.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P-10 WASH FOUNTAIN:

Semicircular - 3 station, 1.9837 mm (14 gauge) stainless steel bowl. Foot control flor mounted, wall waste outlet, top supply, vent off drain, liquid soap supenser.

P-11 {AM#0001} FLOOR MOUNTED MOP BASIN:

Enameled cast iron ASME A112.19.1M, or molded stone corner, floor mounted 711.2 mm (28 inches) square, 171.5 mm (6-3/4 inches) deep.

Faucet and Spout - Cast or wrought copper alloy, with top brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-12 ELECTRIC WATER COOLER:

Drinking fountains shall meet the requirements of NSF 61, Section 9. Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - Surface wall-mounted units shall be 336.6 mm wide, 330.2 mm deep, and have a back height of 152.4 to 203.2 mm . The bowl shall be made of stainless steel. The unit shall have concealed fasteners and be for interior installation.

P-13 ELECTRIC WATER COOLER - ADA

Handicapped - Handicapped units shall be surface wall-mounted. The dimensions shall be 381.0 mm (15 inches) wide, 508.0 mm (20 inches) deep, with a back height of 152.4 to 203.2 mm (6 to 8 inches). The unit shall clear the floor or ground by at least 200 mm (8 inches). A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 685 mm (27 inches) and between the front edge of the bowl and the body of the unit of at least 200 mm (8 inches). A 200 mm (8 inch) wide clear space shall exist on both sides of the unit. The spout height shall be no more than 1 m (36 inches) above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 165.1 mm (6-1/2 inches) high, made of stainless steel and be for interior installation.

P-14 EMERGENCY SHOWER AND EYEWASH

Brass, chrome plated 25 PSI stay-open ball valve. Stainless steel pull rod with triangular handle, galvanized standard with factory safety yellow coating. 254 mm dia. Yellow impact-resistant plastic shower hand and eyewash bowl. Twin-perforated disc eye-wash heads with protective covers. Push handle control. Comply with ANSI Z 358.1 - 1998.

P-15 EMERGENCY EYE WASH

Galvanized pipe standard with factory safety yellow coating. 254 mm dia. yellow impact resistant plastic bowl. Twin soft flow, eyewash heads with protective cover. Comply with ANSI Z 358.1 - 1998.

P-16 FOOD WASTE DISPOSER:

{AM#0001}Garbage disposals shall conform to UL 430; Waste Disposers; continuous feed, minimum 1/2 HP motor, stainless steel grinding elements, two 360-degree stainless steel swivel impellers, manual motor reset, and sound insulation. A plug connector is required.

3.11 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 21 degrees C delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = o (trace is permitted).

SL = Standby loss in W/0.093 sq. m. based on 27 degrees C delta T, or in percent per hour based on nominal 38 degrees C delta T.

HL = Heat loss of tank surface area.

V = Storage volume in liters

3.11.1 Storage Water Heaters

3.11.1.1 Gas

a. Storage capacity of 379 liters or less, and input rating of 21980 W or less: minimum EF shall be 0.62-0.0019V per 10 CFR 430.

b. Storage capacity of more than 379 liters - or input rating more than 21980 W: Et shall be 77 percent; maximum SL shall be 1.3+38/V, per ANSI Z21.10.3.

3.12 TABLES

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

| | | SERVICE | | | | | |
|---|---|---|---|---|---|---|---|
| Item # | Pipe and Fitting Materials | A | B | C | D | E | F |
| 1 | Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets | X | X | X | X | X | |
| 2 | Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888 | | X | X | X | | |
| 3 | Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10 | X | | X | X | | |
| 4 | Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10 | | | | X | X | |
| 5 | Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A 536 and ASTM A 47/A 47M | X | X | | X | X | |
| 6 | Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47/A 47M for use with Item 5 | X | X | | X | X | |
| 7 | Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 5 | X | X | | X | X | |
| 8 | Wrought copper grooved joint pressure pressure fittings for non-ferrous pipe ASTM B 75M C12200, ASTM B 152, ASTM B 152M, C11000, ASME B16.22 ASME B16.22 for use with Item 5 | X | X | | | | |
| 9 | Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10 | | | | X | X | |
| 10 | Steel pipe, seamless galvanized, ASTM A 53/A 53M, Type S, Grade B | X | | | X | X | |
| 11 | Seamless red brass pipe, ASTM B 43 | | X | X | | | |

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

| | | SERVICE | | | | | |
|---|---|---|---|---|---|---|---|
| Item # | Pipe and Fitting Materials | A | B | C | D | E | F |
| 12 | Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14 | | | | X | X | |
| 13 | Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14 | | | | X | X | |
| 14 | Seamless copper pipe, ASTM B 42 | | | | X | | |
| 15 | Cast bronze threaded fittings, ASME B16.15 | | | | X | X | |
| 16 | Copper drainage tube, (DWV), ASTM B 306 | X* | X | X* | X | X | |
| 17 | Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29 | X | X | X | X | X | |
| 18 | Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23 | X | X | X | X | X | |

SERVICE:

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
* - Hard Temper

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

| | | SERVICE | | | |
|---|---|---|---|---|---|
| Item No. | Pipe and Fitting Materials | A | B | C | D |
| 1 | Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a | X | X | X | X |
| | b. Same as "a" but not galvanized for use with Item 4b | | | X | |
| 2 | Grooved pipe couplings, ferrous pipe ASTM A 536 and ASTM A 47/A 47M, non-ferrous pipe, ASTM A 536 and ASTM A 47/A 47M, | X | X | X | |
| 3 | Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47/A 47M, for use with Item 2 | X | X | X | |
| 4 | Steel pipe: a. Seamless, galvanized, ASTM A 53/A 53M, Type S, Grade B | X | X | X | X |
| | b. Seamless, black, ASTM A 53/A 53M, Type S, Grade B | | | X | |
| 5 | Seamless red brass pipe, ASTM B 43 | X | X | | X |
| 6 | Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7 | X | X | | X |
| 7 | Seamless copper pipe, ASTM B 42 | X | X | | X |
| 8 | Seamless copper water tube, ASTM B 88, ASTM B 88M | X** | X** | X** | X*** |
| 9 | Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7 | X | X | | X |
| 10 | Wrought copper and bronze solder-joint pressure fittings, | X | X | X | X |

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

| | | SERVICE | | | |
|---|---|---|---|---|---|
| Item No. | Pipe and Fitting Materials | A | B | C | D |
| | ASME B16.22 for use with Items 5 and 7 | | | | |
| 11 | Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 8 and 9 | X | X | X | X |
| 12 | Bronze and sand castings grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 2 | X | X | X | |
| 32 | Steel pipeline flanges, MSS SP-44 | X | X | | |
| 33 | Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828 | X | X | | |
| 34 | Carbon steel pipe unions, socket-welding and threaded, MSS SP-83 | X | X | X | |
| 35 | Malleable-iron threaded pipe unions ASME B16.39 | X | X | | |
| 36 | Nipples, pipe threaded ASTM A 733 | X | X | X | |

A - Cold Water Aboveground
B - Hot Water 82 degree C Maximum Aboveground
C - Compressed Air Lubricated
D - Cold Water Service Belowground
Indicated types are minimum wall thicknesses.
** - Type L - Hard

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

| | | SERVICE | | | |
|---|---|---|---|---|---|
| Item No. | Pipe and Fitting Materials | A | B | C | D |

*** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors

**** - In or under slab floors only brazed joints

TABLE III
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

A. STORAGE WATER HEATERS

| FUEL | STORAGE CAPACITY LITERS | | INPUT RATING | TEST PROCEDURE | REQUIRED PERFORMANCE |
|---|---|---|---|---|---|
| Gas | 380 max. | | 22 kW max. | 10 CFR 430 | EF = 0.62-0.0019V minimum |
| Gas | 380 min. | OR | 22 kW min. | ANSI Z21.10.3 | ET= 77 percent; SL = 1.3+38/V max. |

TERMS:

EF = Energy factor, overall efficiency.
ET = Thermal efficiency with 21 degrees C delta T.
EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).
SL = Standby loss in W/0.09 sq. m. based on 27 degrees C delta T, or in percent per hour based on nominal 32 degrees C delta T.
HL = Heat loss of tank surface area
V = Storage volume in gallons

-- End of Section --

# SECTION 15556

# FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS
**05/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designations only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless |
| ASTM A 105/A 105M | (2001) Carbon Steel Forgings for Piping Applications |
| ASTM A 106 | (1999el) Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A 193/A 193M | (2000a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A 234/A 234M | (2001a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A 366/A 366M | (1997el) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality |
| ASTM A 515/A 515M | (1989; R 1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service |
| ASTM A 516/A 516M | (1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A 569/A 569M | (2000) Commercial Steel (CS) Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated |

| | |
|---|---|
| | (Galvannealed) by the Hot-Dip Process |
| ASTM A 733 | (1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples |
| ASTM B 32 | (1996) Solder Metal |
| ASTM B 62 | (1993) Composition Bronze or Ounce Metal Castings |
| ASTM B 75 | (1999) Seamless Copper Tube |
| ASTM B 88 | (1999) Seamless Copper Water Tube |
| ASTM B 88M | (1999) Seamless Copper Water Tube (Metric) |
| ASTM B 251 | (1997) General Requirements for Wrought Seamless Copper and Copper-Alloy Tube |
| ASTM B 650 | (1995) Electrodeposited Engineering Chromium Coatings of Ferrous Substrates |
| ASTM B 687 | (1999) Brass, Copper, and Chromium-Plated Pipe Nipples |
| ASTM B 813 | (2000) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube |
| ASTM B 828 | (2000) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings |
| ASTM D 596 | (1991; R 1995) Reporting Results of Analysis of Water |
| ASTM D 1248 | (2000) Polyethylene Plastics Molding and Extrusion Materials |
| ASTM D 3308 | (1997) PTFE Resin Skived Tape |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.1 | (1998) Cast Iron Pipe Flanges and Flanged Fittings |
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.4 | (1998) Gray Iron Threaded Fittings |
| ASME B16.5 | (1996; B16.5a) Pipe Flanges and Flanged |

| | |
|---|---|
| | Fittings NPS 1/2 thru NPS 24 |
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.15 | (1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250 |
| ASME B16.18 | (1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.22 | (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (1988) Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.39 | (1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300 |
| ASME B31.1 | (1998) Power Piping |
| ASME B40.1 | (1991) Gauges - Pressure Indicating Dial Type - Elastic Element |
| ASME BPV VIII Div 1 | (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage |
| ASME BPV IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8 | (1992) Filler Metals for Brazing and Braze Welding |

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

| | |
|---|---|
| EJMA Stds | (1998; 7th Edition) EJMA Standards |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-25 | (1998) Standard Marking System for Valves, Fittings, Flanges and Unions |

| | |
|---|---|
| MSS SP-58 | (1993) Pipe Hangers and Supports - Materials, Design and Manufacture |
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |
| MSS SP-70 | (1998) Cast Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-71 | (1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends |
| MSS SP-80 | (1997) Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-85 | (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends |

PLUMBING-HEATING-COOLING CONTRACTORS NATIONAL ASSOCIATION (NAPHCC)

| | |
|---|---|
| NAPHCC Plumbing Code | (1996) National Standard Plumbing Code |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (1997) Enclosures for Electrical Equipment (1000 Volts Maximum) |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heating System.

Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Spare Parts; G, RE.

Spare parts data for each different item of material and equipment specified , after approval of the related submittals and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Welding; G.

3 copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations.

Framed Instructions.

Proposed diagrams, instructions, and other sheets, prior to posting. The instructions shall show wiring and control diagrams and complete layout of the entire system. The instructions shall include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system.

SD-06 Test Reports

Testing and Cleaning.

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

Water Treatment Testing.

The water quality test report shall identify the chemical composition of the heating water. The report shall include a comparison of the condition of the water with the chemical company's recommended conditions. Any required corrective action shall be documented within the report.

SD-07 Certificates

Bolts.

Written certification that the bolts furnished comply with the requirements of this specification, provided by the bolt manufacturer. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

SD-10 Operation and Maintenance Data

Heating System; G, RE.

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set, prior to performance testing and the remainder upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, water treatment procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be provided prior to the field training course.

## 1.3 QUALIFICATIONS

Procedures and welders shall be qualified in accordance with the code under which the welding is specified to be accomplished.

## 1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

## 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

# PART 2 PRODUCTS

## 2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

### 2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

### 2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

### 2.1.3 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

#### 2.1.4 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

#### 2.1.5 Electrical Work

Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electric equipment (including motor efficiencies), and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. High efficiency motors shall be used. Electrical characteristics shall be as specified or indicated. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring, conduit, and connection to power required for controls and devices but not shown shall be provided.

### 2.2 PIPING, TUBING, AND FITTINGS

#### 2.2.1 General

Piping, tubing, and fittings shall be as follows:

a. Low temperature water piping shall be black steel or copper tubing with cast iron, malleable iron or steel, solder-joint or flared-tube fittings.

b. Vent piping shall be black steel, Schedule 40, with black malleable iron fittings.

#### 2.2.2 Steel Pipe

Pipe shall conform to ASTM A 53/A 53M or ASTM A 106, Grade A or B, black steel, Schedule 40, unless otherwise specified. Steel pipe to be bent shall be ASTM A 53/A 53M, Grade A, standard, or Grade B, extra strong weight. Steam pipe shall be ASTM A 53/A 53M Grade A.

#### 2.2.3 Gauge Piping

Black steel, ASTM A 106, seamless, Grade A pipe shall be used for high temperature.

#### 2.2.4 Copper Tubing

Tubing shall conform to ASTM B 88, ASTM B 88M, Type K or L. Tubing for compressed air tubing shall conform to ASTM B 251M .

### 2.2.5 Malleable Iron Pipe Fittings

Fittings shall conform to ASME B16.3, type required to match adjacent piping.

### 2.2.6 Cast Iron Pipe Fittings

Fittings shall conform to ASME B16.1 or ASME B16.4 type required to match adjacent piping.

### 2.2.7 Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

#### 2.2.7.1 Welded Fittings

Welded fittings shall conform to ASTM A 234/A 234M with WPA marking. Butt welded fittings shall conform to ASME B16.9, and socket welded fittings shall conform to ASME B16.11.

### 2.2.8 Fittings for Copper Tubing

Wrought copper and bronze fittings shall conform to ASME B16.22 and ASTM B 75M . Cast copper alloy fittings shall conform to ASME B16.18 and ASTM B 828. Flared fittings shall conform to ASME B16.26 and ASTM B 62. Adaptors may be used for connecting tubing to flanges and threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Cast bronze threaded fittings shall conform to ASME B16.15.

### 2.2.9 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns., etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

### 2.2.10 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

### 2.2.11 Nipples

Nipples shall conform to ASTM A 733 or ASTM B 687, standard weight.

### 2.2.12 Unions

Unions shall conform to ASME B16.39, type to match adjacent piping.

### 2.2.13 Adapters

Adapters for copper tubing shall be brass or bronze for soldered fittings.

### 2.2.14 Dielectric Unions

Unions shall conform to the tensile strength and dimensional requirements specified in ASME B16.39. Unions shall have metal connections on both ends to match adjacent piping. Metal parts of dielectric unions shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact.

### 2.2.15 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 1.034 MPa (150 psi) or 1.034 MPa (150 psi) service as appropriate for the static head plus the system head, and 121 degrees C (250 degrees F). Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, temperature, and circulating medium. The flexible section may have threaded, welded, soldered, flanged, grooved, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

## 2.3 MATERIALS AND ACCESSORIES

### 2.3.1 Iron and Steel Sheets

#### 2.3.1.1 Galvanized Iron and Steel

Galvanized iron and steel shall conform to ASTM A 653/A 653M, with general requirements conforming to ASTM A 653/A 653M. Gauge numbers specified are Manufacturer's Standard Gauge.

#### 2.3.1.2 Uncoated (Black) Steel

Uncoated (black) steel shall conform to ASTM A 366/A 366M or ASTM A 569/A 569M, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to Manufacturer's Standard Gauge.

### 2.3.2 Solder

Solder shall conform to ASTM B 32. Solder and flux shall be lead free. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

### 2.3.3 Solder, Silver

Silver solder shall conform to AWS A5.8.

2.3.4 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 225 mm (9 inch) scale, and thermometers shall have rigid stems with straight, angular, or inclined pattern.

2.3.5 Gauges

Gauges shall conform to ASME B40.1.

2.3.6 Gaskets for Flanges

Composition gaskets shall conform to ASME B16.21. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 6.6 mm (1/16 inch) thickness, full face or self-centering flat ring type. Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Gaskets shall be suitable for pressure and temperatures of piping system.

2.3.7 Polyethylene Tubing

Low-density virgin polyethylene shall conform to ASTM D 1248, Type I, Category 5, Class B or C.

2.3.8 Bellows-Type Joints

Joints shall be flexible, guided expansion joints. Expansion element shall be of stainless steel. Bellows-type expansion joints shall be in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.3.9 Expansion Joints

Expansion joints shall provide for either single or double slip of connected pipes, as required or indicated, and for not less than the traverse indicated. Joints shall be designed for hot water working pressure not less than 862 kPa (125 psig) and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. Joints shall be designed for packing injection under full line pressure. End connections shall be flanged or beveled for welding as indicated. Joints shall be provided with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 0 0508 mm (2 mils) of hard chrome conforming to ASTM B 650. Joint components shall be fabricated from material equivalent to that of the pipeline. Initial settings shall be made in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by joint manufacturer, but in any case shall not be more than 1.5 m from expansion joint except for lines 100 mm (4 inches) or smaller, guides shall be installed not more than 600 mm (2 feet) from the joint. Service outlets shall be provided where indicated.

2.3.10 Flexible Ball Joints

Flexible ball joints shall be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. Joint ends shall be threaded (to 50.8 mm (2 inches) only), grooved, flanged or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation. Balls and sockets shall be of equivalent material as the adjoining pipeline. Exterior spherical surface of carbon steel balls shall be plated with 0.0508 mm (2 mils) of hard chrome conforming to ASTM B 650. Ball type joints shall be designed and constructed in accordance with ASME B31.1 and ASME BPV VIII Div 1, where applicable. Flanges where required shall conform to ASME B16.5. Gaskets and compression seals shall be compatible with the service intended.

2.3.11 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.4 VALVES FOR LOW TEMPERATURE WATER HEATING AND STEAM SYSTEMS

2.4.1 Check Valves

Sizes 65 mm (2-1/2 inches) and less, bronze shall conform to MSS SP-80, Type 3 or 4, Class 125. Sizes 80 mm (3 inches) through 300 mm (24 inches), cast iron shall conform to MSS SP-71, Type III or IV, Class 125.

2.4.2 Globe Valves

Sizes 65 mm (2-1/2 inches) and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm (3 inches) through 300 mm (12 inches), cast iron shall conform to MSS SP-85, Type III, Class 125.

2.4.3 Angle Valves

Sizes 65 mm (2-1/2 inches) and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm (3 inches) through 300 mm (12 inches), cast iron shall conform to MSS SP-85, Type III, Class 125.

2.4.4 Gate Valves

Sizes 65 mm (2-1/2 inches) and less, bronze shall conform to MSS SP-80, Type 1 or 2, Class 125. Sizes 80 mm (3 inches) through 1200 mm (48 inches), cast iron shall conform to MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

2.4.5 Air Vents

Air vents shall be provided at all piping high points in water systems, with block valve in inlet and internal check valve to allow air vent to be isolated for cleaning and inspection. Outlet connection shall be piped to nearest open site or suitable drain, or terminated 300 mm above finished grade. Pressure rating of air vent shall match pressure rating of piping system. Body and cover shall be cast iron or semi-steel with stainless steel or copper float and stainless steel or bronze internal parts. Air vents installed in piping in chase walls or other inaccessible places shall be provided with an access panel.

#### 2.4.6 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register degree of valve opening. Valves shall be calibrated so that flow in liters per minute (gpm) can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves shall be suitable for 121 degrees C (250 degrees F) temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing. Plug valves and ball valves 200 mm (8 inches) or larger shall be provided with manual gear operators with position indicators.

#### 2.4.7 Gravity Flow Control Valves

Ends shall be soldered, threaded, or flanged type as applicable, and designed for easy cleaning without disconnecting piping. Valves for copper tubing shall be bronze. Valves shall prevent flow due to gravity when circulators are off.

### 2.5 COLD WATER CONNECTIONS

Connections shall be provided which include consecutively in line a strainer, backflow prevention device, and water pressure regulator. The backflow prevention device shall be provided as indicated and in compliance with Section 15400 PLUMBING, GENERAL PURPOSE.

#### 2.5.1 Strainers

Basket or Y-type strainers shall be the same size as the pipelines in which they are installed. Strainer bodies shall be rated for 862 kPa (125 psi) service, with bottoms drilled and plugged. Bodies shall have arrows cast on the sides to indicate the direction of flow. Each strainer shall be equipped with a removable cover and sediment basket. Basket shall not be less than 0.795 mm (22 gauge) and shall have perforations to provide a net free area through the basket of at least four times that of the entering pipe.

### 2.5.2 Pressure Regulating Valve

Valve shall be a type that will not stick nor allow pressure to build up on the low side. Valve shall be set to maintain a terminal pressure approximately 35 kPa (5 psi) in excess of the static head on the system and shall operate within a 138 kPa (20 psi) variation regardless of initial pressure and without objectionable noise under any condition of operation.

## 2.6 EXPANSION TANK

Pressurization system shall include a replaceable diaphragm-type captive air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. Sizes shall be as indicated. Expansion tank shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa (125 psig) and precharged to the minimum operating pressure. Tank air chamber shall be fitted with an air charging valve. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations.

## 2.7 AIR SEPARATOR TANK

External air separation tank shall be steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa (125 psi) . The capacity of the air separation tank indicated is minimum.

## 2.8 SYSTEM EQUIPMENT AND ACCESSORIES

### 2.8.1 Circulating Pumps

Pumps for hot water shall be of the single-stage centrifugal type, electrically driven. Pumps shall be supported on a concrete foundation or by the piping on which installed as indicated. Pumps shall be either integrally mounted with the motor or direct-connected by means of a flexible-shaft coupling on a cast iron, or steel sub-base. Pump housing shall be of close grained cast iron. Shaft shall be carbon or alloy steel, turned and ground. Shaft seal shall be mechanical-seal or stuffing-box type. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Bearings shall be ball-, roller-, or oil-lubricated, bronze-sleeve type, and shall be sealed or isolated to prevent loss of oil or entrance of dirt or water. Motor shall be of a type approved by the manufacturer of the pump.

### 2.8.2 Pressure Gauges and Thermometers

Gauges shall be provided for each heat exchanger and piping as indicated. A thermometer and pressure gauge shall be provided on the high temperature water supply and return mains. Thermometers shall be separable socket type.

#### 2.8.3 Strainers

Basket or Y-type strainer-body connections shall be the same size as the pipe lines in which the connections are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with nipple and gate valve for blowdown. The basket for steam systems shall be of not less than 0.635 mm (0.025 inch) thick stainless steel, or monel with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow shall be into the basket and out through the perforations.

## 2.9 INSULATION

Shop and field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.10 FACTORY PAINTED EXPOSED SPACE HEATING EQUIPMENT

Radiator and convector enclosures shall be coated with the manufacturer's standard rust inhibiting primer for painting in the field as specified in Section 09900 PAINTING, GENERAL. All other exposed heating equipment shall be painted at the factory with the manufacturer's standard primer and enamel finish.

## 2.11 UNIT HEATERS

Heaters shall be as specified below, and shall have a heating capacity not in excess of 125 percent of the capacity indicated. Noise level of each unit heater for areas noted shall not exceed the criteria indicated.

### 2.11.1 Propeller Fan Heaters

Heaters shall be designed for suspension and arranged for horizontal or vertical discharge of air as indicated. Casings shall be not less than 0.912 mm (20 gauge) black steel and finished with lacquer or enamel. Suitable stationary deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Fans for vertical discharge type heaters shall operate at speeds not in excess of 1,200 rpm, except that units with 84.4 MJ (80,000 Btu) output capacity or less may operate at speeds up to 1,800 rpm. Horizontal discharge type unit heaters shall have discharge or face velocities not in excess of the following:

| Unit Capacity, Liters per Second | Face Velocity, Meters per Second |
|---|---|
| Up to 472 (1000) | 4.06 (800) |
| 473 (1001) | 4.57 (900) |
| 1417 (3001) | 5.08 (1,000) |

### 2.11.2 Heating Elements

Heating coils and radiating fins shall be of suitable nonferrous alloy with brazed fittings at each end for connecting to external piping. The heating elements shall be free to expand or contract without developing leaks and shall be properly pitched for drainage. The elements shall be tested under a hydrostatic pressure of 1.38 MPa (200 psig) and a certified report of the test shall be submitted to the Contracting Officer.

### 2.11.3 Motors

Motors shall be provided with NEMA 250 general purpose enclosure. Motors and motor controls shall otherwise be as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

### 2.11.4 Motor Switches

Motors shall be provided with manual selection switches with "Off," and "Automatic" positions and shall be equipped with thermal overload protection.

### 2.11.5 Controls

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING, AND AIR CONDITIONING HVAC CONTROL SYSTEMS.

## 2.12 HEATING AND VENTILATING UNITS

Heating and ventilating units shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS.

## 2.13 WATER TREATMENT SYSTEM

The water treatment system shall be capable of manually feeding chemicals into the heating system to prevent corrosion and scale within the heat exchanger and piping system. All water treatment equipment and chemicals shall be furnished and installed by a water treatment company regularly engaged in the installation of water treatment equipment and the provision of water treatment chemicals based upon water condition analyses. The water treatment company shall provide a water sample analysis taken from the building site, each month for one year.

### 2.13.1 Chemical Shot Feeder

A shot feeder shall be provided as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping. All materials of construction shall be compatible with the chemicals being used.

### 2.13.2 Chemicals

The chemical company shall provide pretreatment chemicals that will remove and permit flushing of mill scale, oil, grease, and other foreign matter from the water heating system. The chemical company shall also provide all treatment chemicals required for the initial fill of the system and for a period of one year of operation. The chemical company shall determine the correct chemicals and concentrations required for the water treatment. The chemicals shall not be proprietary and shall meet required federal, state, and local environmental regulations for the treatment of heating water systems and discharge to the sanitary sewer. The chemicals shall remain stable throughout the operating temperature range of the system, and shall be compatible with pump seals and other elements of the system.

### 2.13.3 Test Kits

All required test kits and reagents for determining the proper water conditions shall be provided.

## PART 3 EXECUTION

### 3.1 INSTALLATION

All work shall be installed as indicated and in accordance with the manufacturer's diagrams and recommendations.

### 3.2 COLOR CODE MARKING AND FIELD PAINTING

Color code marking, field painting of exposed pipe, and field painting of factory primed equipment shall be as specified in Section 09900 PAINTING, GENERAL.

### 3.3 WELDING

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section {AM#0001} 05090 WELDING, STRUCTURAL.

### 3.4 PIPING

Unless otherwise specified, pipe and fittings installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cuttings or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Changes in direction shall be made with factory made fittings, except that bending of pipe up to 100 mm (4 inches) will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bends shall not be less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be installed through the roof as indicated and shall be flashed as specified. Horizontal mains shall pitch up or down in the direction of flow as indicated. The grade shall be not less than 25 mm in 12 m. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unions and other components for copper pipe or tubing shall be brass or bronze. Connections between ferrous and copper piping shall be electrically isolated using dielectric unions.

### 3.4.1 Joints

Except as otherwise specified, joints used on steel pipe shall be threaded for fittings 25 mm (1 inch) and smaller; threaded or welded for 32 mm (1-1/4 inches) up through 65 mm (2-1/2 inches); and flanged or welded for 80 mm (3 inches) and larger. Joints between sections of copper tubing or copper pipe shall be flared or sweated. Pipe and fittings 32 mm (1-1/4 inches) and larger installed in inaccessible conduits or trenches beneath concrete floor slabs shall be welded. Unless otherwise specified, connections to equipment shall be made with black malleable iron unions for pipe 65 mm (2-1/2 inches) or smaller in diameter, and with flanges for pipe 80 mm (3 inches) or larger in diameter.

### 3.4.2 Low Temperature Systems

Piping may have threaded, welded, flanged or flared or sweated joints as applicable and as specified. Reducing fittings shall be used for changes in pipe sizes. In horizontal lines, reducing fittings shall be the eccentric type to maintain the top of the adjoining pipes at the same level.

### 3.4.3 Threaded Joints

Threaded joints shall be made with tapered threads properly cut, and shall be made tight with PTFE tape complying with ASTM D 3308, or equivalent thread joint compound applied to the male threads only, and in no case to the fittings.

### 3.4.4 Welded Joints

Joints shall be fusion-welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only. Branch connection may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains.

### 3.4.5 Flanged Joints or Unions

Flanged joints or unions shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and similar items.

Flanged joints shall be faced true, provided with gaskets, and made square and tight. Full-faced gaskets shall be used with cast iron flanges.

#### 3.4.6 Flared and Sweated Pipe and Tubing

Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Installation shall be made in accordance with the manufacturer's recommendations. Changes in direction of piping shall be made with flared or soldered fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder. Cored solder shall not be used. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing.

#### 3.4.7 Mechanical Tee Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Joints shall be brazed in accordance with NAPHCC Plumbing Code. Soldered joints will not be permitted.

### 3.5 CONNECTIONS TO EQUIPMENT

Supply and return connections shall be provided by the Contractor unless otherwise indicated. Valves and traps shall be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment shall be not smaller than the connections on the equipment. No bushed connections shall be permitted. Change in sizes shall be made with reducers or increasers only.

#### 3.5.1 Low Temperature Water Connections

Connections, unless otherwise indicated, shall be made with malleable iron unions for piping 65 mm (2-1/2 inches) or less in diameter and with flanges for pipe 80 mm (3 inches) or more in diameter.

### 3.6 BRANCH CONNECTIONS

Branches shall pitch up or down as indicated, unless otherwise specified. Connection shall be made to insure unrestricted circulation, eliminate air pockets, and permit drainage of the system.

#### 3.6.1 Low Temperature Water Branches

Branches taken from mains shall pitch with a grade of not less than 25 mm in 3 m (1 inch in 10 feet).

## 3.7 RISERS

The location of risers is approximate. Exact locations of the risers shall be as approved.

## 3.8 SUPPORTS

### 3.8.1 General

Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers. Where threaded rods are used for support, they shall not be formed or bent.

#### 3.8.1.1 Seismic Requirements for Pipe Supports, Standard Bracing

All piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 15070SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT . Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for supports shall be as specified under Section 05120 STRUCTURAL STEEL.

#### 3.8.1.2 Structural Attachments

Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist panel points shall not exceed 222 N (50 pounds). Loads exceeding 222 N (50 pounds) shall be suspended from panel points.

#### 3.8.1.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.

### 3.8.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as specified as follows:

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle shall be used on all pipe 100 mm (4 inches) and larger.

h. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves.

i. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m, except that pipe shall be supported not more than 2.4 m from end of risers, and at vent terminations.

j. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm (4 inches), a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm (4 inches), or by an amount adequate for the insulation, which ever is greater.

k. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

### 3.8.3 Piping in Trenches

Piping shall be supported as indicated.

## 3.9 PIPE SLEEVES

### 3.9.1 Pipe Passing Through Concrete or Masonry

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Unless otherwise indicated, sleeves shall provide a minimum of 6 mm annular space between bare pipe or insulation surface and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls and floors shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Penetrations in fire walls and floors shall be sealed in accordance with Section 07840 FIRESTOPPING.

### 3.9.2 Pipes Passing Through Waterproofing Membranes

Pipes passing through waterproofing membranes shall be installed through a 19.5 kg/square meter (4 pound) lead-flashing sleeve, a 4.9 kg/square meter (16 ounce) copper sleeve, or a 0.813 mm (0.032 inch) thick aluminum sleeve, each having an integral skirt or flange. Flashing sleeve shall be suitably formed, and the skirt or flange shall extend 200 mm or more from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 50 mm above the highest flood level of the roof or a minimum of 250 mm above the roof, whichever is greater, or 250 mm above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. At the Contractor's option, pipes up to and including 250 mm (10 inches) in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

### 3.9.3 Counterflashing Alternate

As an alternate to caulking and sealing the annular space between the pipe and flashing sleeve or metal-jacket-covered insulation and flashing sleeve, counterflashing may be by standard roof coupling for threaded pipe up to 150 mm (6 inches) in diameter; lead-flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; or tack-welded or banded-metal rain shield round the pipe and sealing as indicated.

3.9.4 Waterproofing Clamping Flange

Pipe passing through wall waterproofing membrane shall be sleeved as specified. In addition, a waterproofing clamping flange shall be installed as indicated.

3.9.5 Fire Seal

Where pipes pass through fire walls, fire partitions, fire rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.9.6 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.10 ANCHORS

Anchors shall be provided where necessary or indicated to localize expansion or prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed using turnbuckles where required. Supports, anchors, or stays shall not be attached in places where construction will be damaged by installation operations or by the weight or expansion of the pipeline.

3.11 PIPE EXPANSION

The expansion of supply and return pipes shall be provided for by changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated. Low temperature water expansion joints may be one of the types specified.

3.11.1 Expansion Loops

Expansion loops shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops shall be cold-sprung and installed where indicated. Pipe guides shall be provided as indicated.

3.11.2 Slip-Tube Joints

Slip-tube type expansion joints shall be used for low temperature water systems only and shall be installed where indicated. The joints shall provide for either single or double slip of the connected pipes as indicated and for the traverse indicated. The joints shall be designed for a working temperature and pressure suitable for the application and in no case less than 862 kPa (125 psig). The joints shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connections shall be flanged. Anchor bases or support bases shall be provided as indicated or required. Initial setting shall be made in accordance with the manufacturer's recommendations to allow for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall be not more than 1.5 m from expansion joint, except in lines 100 mm (4 inches) or smaller where guides shall be installed not more that 600 mm from the joint.

### 3.11.3 Bellows-Type Joint

Bellows-type joint design and installation shall comply with EJMA Stds standards. The joints shall be designed for the working temperature and pressure suitable for the application and shall be not less than 1.03 MPa (150 psig) in any case.

### 3.11.4 Flexible Ball Joints

Flexible ball joints may be threaded (to 50 mm (2 inches) only), flanged, or welded end as required. The ball-type joint shall be designed and constructed in accordance with the generally accepted engineering principle stated in ASME B31.1, and ASME BPV VIII Div 1, where applicable. Flanges shall conform to the diameter and drilling of ASME B16.5. Molded gaskets furnished shall be suitable for the service intended.

## 3.12 VALVES AND EQUIPMENT ACCESSORIES

### 3.12.1 Valves and Equipment

Valves shall be installed at the locations shown or specified, and where required for the proper functioning of the system as directed. Gate valves shall be used unless otherwise indicated, specified, or directed. Valves shall be installed with their stems horizontal to or above the main body of the valve. Valves used with ferrous piping shall have threaded or flanged ends and sweat-type connections for copper tubing.

### 3.12.2 Gravity Flow-Control Valve

The valve to control the flow of water shall be installed in the supply main near the heat exchanger. The valve shall operate so that when the circulating pump starts, the increased pressure within the main will open the valve; when the pump stops, the valve will close. The valve shall be constructed with a cast iron body and shall be provided with a device whereby the valve can be opened manually to allow gravity circulation. The flow-control valve shall be designed for the intended purpose, and shall be installed as recommended by the manufacturer.

### 3.12.3 Thermometer Socket

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

3.12.4 Air Vents

Vents shall be installed where indicated, and on all high points and piping offsets where air can collect or pocket.

3.12.4.1 Water Air Vents

Low temperature water air vents shall be as indicated. Vent discharge lines shall be double-valved with globe valves and shall discharge into a funnel drain.

3.13 UNIT HEATERS

Unit heaters shall be installed as indicated and in accordance with the manufacturer's instructions.

3.14 INSULATION

Thickness of insulation materials for piping and equipment and application shall be in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.15 TESTING AND CLEANING

3.15.1 Pressure Testing

The Contractor shall notify the Contracting Officer 2 days before the tests are to be conducted. The tests shall be performed in the presence of the Contracting Officer. The Contractor shall furnish all instruments and personnel required for the tests. Electricity, steam, and water will be furnished by the Government. All test results shall be accepted before thermal insulation is installed. The entire low temperature heating system, including heat exchanger, radiators and fittings, shall be hydrostatically tested and proved tight under a pressure of 310 kPa (45 psig) for a period of four hours.

3.15.2 Test of Backflow Prevention Assemblies

Backflow prevention assemblies shall be tested in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

3.15.3 Cleaning

After the hydrostatic and backflow prevention tests have been made and prior to the operating tests, the heat exchanger and piping shall be thoroughly cleaned by filling the system with a solution of 0.5 kg of caustic soda or 0.5 kg of trisodium phosphate per 200 L of water. Observe the proper safety precautions in the handling and use of these chemicals. The water shall be heated to approximately 66 degrees C, and the solution circulated in the system for a period of 48 hours, then drained and the system thoroughly flushed out with fresh water. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. The Contractor shall be responsible for maintaining the system in a clean condition until final acceptance. Bearings shall be lubricated with oil or grease as recommended by the manufacturer.

3.15.4 Water Treatment Testing

3.15.4.1 Water Quality Test

The heating water shall be analyzed prior to the acceptance of the facility and a minimum of once a month for a period of one year by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

| | |
|---|---|
| Date of Sample | _____ |
| Temperature | _____ degrees C |
| Silica (SiO2) | _____ ppm (mg/1) |
| Insoluble | _____ ppm (mg/1) |
| Iron and Aluminum Oxides | _____ ppm (mg/1) |
| Calcium (Ca) | _____ ppm (mg/1) |
| Magnesium (Mg) | _____ ppm (mg/1) |
| Sodium and Potassium (Na and K) | _____ ppm (mg/1) |
| Carbonate (HCO3) | _____ ppm (mg/1) |
| Sulfate (SO4) | _____ ppm (mg/1) |
| Chloride (C1) | _____ ppm (mg/1) |
| Nitrate (NO3) | _____ ppm (mg/1) |
| Turbidity | _____ unit |
| pH | _____ |
| Residual Chlorine | _____ ppm (mg/1) |
| Total Alkalinity | _____ ppm (meq/1) |
| Noncarbonate Hardness | _____ epm (meq/1 |
| Total Hardness | _____ epm (meq/1) |
| Dissolved Solids | _____ ppm (mg/1) |
| Fluorine | _____ ppm (mg/1) |
| Conductivity | _____ microsiemens/cm |

3.16 TESTING, ADJUSTING AND BALANCING

Except as specified herein, testing, adjusting, and balancing shall be in accordance with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.17 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.18 FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

## 3.19 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 8 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the approved operation and maintenance manuals.

-- End of Section --

# SECTION 15569

## WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH
**12/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

| | |
|---|---|
| AMCA 801 | (1992) Industrial Process/Power Generation Fans: Specification Guidelines |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z21.13 | (1991; Z21.13a; Z21.13b) Gas-Fired Low-Pressure Steam and Hot Water Boilers |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 105/A 105M | (2001) Carbon Steel Forgings for Piping Applications |
| ASTM A 167 | (1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A 183 | (1998) Carbon Steel Track Bolts and Nuts |
| ASTM A 193/A 193M | (2001a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A 234/A 234M | (2001a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A 366/A 366M | (1997el) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality |
| ASTM A 515/A 515M | (1989; R 1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service |
| ASTM A 516/A 516M | (1990; R 1996) Pressure Vessel Plates, |

| | |
|---|---|
| | Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 536 | (1999el) Ductile Iron Castings |
| ASTM A 653/A 653M | (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B 32 | (1996) Solder Metal |
| ASTM B 62 | (1993) Composition Bronze or Ounce Metal Castings |
| ASTM B 75 | (1999) Seamless Copper Tube |
| ASTM B 813 | (2000) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube |
| ASTM B 828 | (2000) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings |
| ASTM B 88 | (1999) Seamless Copper Water Tube |
| ASTM B 88M | (1999) Seamless Copper Water Tube (Metric) |
| ASTM C 155 | (1997) Standard Classification of Insulating Firebrick |
| ASTM C 27 | (1998) Fireclay and High-Alumina Refractory Brick |
| ASTM C 34 | (1996) Structural Clay Load-Bearing Wall Tile |
| ASTM C 401 | (1991; R 1995el) Alumina and Alumina-Silicate Castable Refractories |
| ASTM D 1784 | (1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D 2000 | (1999) Rubber Products in Automotive Applications |
| ASTM D 596 | (1991; R 1995) Reporting Results of Analysis of Water |
| ASTM F 1097 | (1991; R 1996) Mortar, Refractory |

| | |
|---|---|
| | (High-Temperature, Air-Setting) |
| ASTM F 872 | (1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type, Cleanable |

AMERICAN WATER WORKS ASSOCIATION(AWWA)

| | |
|---|---|
| AWWA C606 | (1997) Grooved and Shouldered Joints |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8 | (1992) Filler Metals for Brazing and Braze Welding |
| AWS B2.2 | (1991) Brazing Procedure and Performance Qualification |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.15 | (1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250 |
| ASME B16.18 | (1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.22 | (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (1988) Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.34 | (1997) Valves - Flanged, Threaded, and Welding End |
| ASME B16.39 | (1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300 |
| ASME B16.4 | (1998) Gray Iron Threaded Fittings |
| ASME B16.5 | (1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24 |

| | |
|---|---|
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B31.1 | (1998) Power Piping |
| ASME B31.5 | (1992; B31.5a1994) Refrigeration Piping |
| ASME B40.1 | (1991) Gauges - Pressure Indicating Dial Type - Elastic Element |
| ASME BPVC SEC IV | (1998) Boiler and Pressure Vessel Code; Section IV, Heating Boilers |
| ASME BPVC SEC IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |
| ASME BPVC SEC VIII D1 | (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage |
| ASME CSD-1 | (1998) Controls and Safety Devices for Automatically Fired Boilers |

COPPER DEVELOPMENT ASSOCIATION (CDA)

| | |
|---|---|
| CDA Tube Handbook | (1995) Copper Tube Handbook |

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

| | |
|---|---|
| EJMA Stds | (1998; 7th Edition) EJMA Standards |

HYDRONICS INSTITUTE DIVISION OF GAMA (HYI)

| | |
|---|---|
| HYI-400 | (1998) I=B=R Product Floor Heating |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-110 | (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |
| MSS SP-25 | (1998) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (1993) Pipe Hangers and Supports - Materials, Design and Manufacture |
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |
| MSS SP-70 | (1998) Cast Iron Gate Valves, Flanged and |

| | |
|---|---|
| | Threaded Ends |
| MSS SP-71 | (1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends |
| MSS SP-72 | (1999) Ball Valves with Flanged or Butt-Welding Ends for General Service |
| MSS SP-73 | (1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings |
| MSS SP-78 | (1998) Cast Iron Plug Valves, Flanged and Threaded Ends |
| MSS SP-80 | (1997) Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-85 | (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 54 | (1999) National Fuel Gas Code |
| NFPA 8501 | (1997) Single Burner Boiler Operation |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-1419 | (Rev D; Canc. Notice 1) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1738 | (1993; Rev thru Mar 1998) Venting Systems for Gas-Burning Appliances, Categories II, III and IV |
| UL Gas&Oil Dir | (1999) Gas and Oil Equipment Directory |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Heating System; G, RE.
Piping Installation; G, RE.

Detail drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor (not required for radiant floor tubing), and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-03 Product Data

Manufacturer's Catalog Data; G, ED.

Manufacturer's catalog data shall be included with the detail drawings for the following items:

Boilers
Fuel Burning Equipment
Combustion Control Equipment
Pumps
Fittings and Accessories

Water Treatment System

The data shall show model, size, options, etc., that are intended for consideration. Data submitted shall be adequate to demonstrate compliance with contract requirements.

Spare Parts Data; G, ED.

Spare parts data for each different item of material and equipment, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

Water Treatment Plan; G, RE.
Boiler Water Treatment; G, RE.

Six complete copies of the proposed water treatment plan. The plan shall include a layout, control scheme, a list of the existing water conditions including the items listed in paragraph BOILER WATER TREATMENT, a list of all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

Heating System Tests; G, RE.
Fuel System Tests; G, RE.

Proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

Welding; G, RE.

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

Qualification; G, RE.

A statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section.

Field Instructions; G, RE.

System layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items shall be posted where directed.

Tests; G, RE.

Proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing.

SD-06 Test Reports

Heating System Tests; G, RE.
Fuel System Tests; G, RE.

Test reports for the heating system tests and the fuel system test, upon completion of testing complete with results.

Water Treatment Tests; G, RE.

a. The water quality test report shall identify the chemical composition of the boiler water. The report shall include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Any required corrective action shall be documented within the report.

b. A test report shall identify the condition of the boiler at the completion of 1 year of service. The report shall include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions.

SD-07 Certificates

Bolts.

Written certification by the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

Continuous Emissions Monitoring.

Written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. The certification shall also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, the certification shall indicate the reason for the exemption.

SD-10 Operation and Maintenance Data

Heating System; G, RE.

Six complete manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization shall be capable of providing 8 hours onsite response to a service call on an emergency basis.

Water Treatment System; G, RE.

Six complete copies of operating and maintenance manuals for the step-by-step water treatment procedures, including procedures for testing the water quality.

## 1.3 GENERAL REQUIREMENTS

### 1.3.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

### 1.3.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

### 1.3.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment. Each pressure vessel shall have an approved ASME stamp.

### 1.3.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500A MISCELLANEOUS METAL.

### 1.3.5 Verification of Dimensions

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

### 1.3.6 Welding

Boilers and piping shall be welded and brazed in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section {AM#0001} 05090 WELDING, STRUCTURAL. {AM#0001}

## 1.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installing, adjusting, and testing of the equipment.

## 1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

## PART 2 PRODUCTS

### 2.1 BOILERS

Each boiler shall have the output capacity in kilowatts (kW) as indicated when fired with the specified fuels. The boiler shall be furnished complete with the gas burning equipment, boiler fittings and trim, automatic controls, forced draft fan, electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers shall be designed, constructed, and equipped in accordance with ASME BPVC SEC IV. Each boiler shall be of the watertube or cast iron type and designed for water service as specified herein. The boiler capacity shall be based on the ratings shown in HYI-01 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

#### 2.1.1 Watertube Boiler

The boiler shall be a standard finned type of water tube boiler. Boiler shall be self-contained, packaged type, complete with all accessories, mounted on a structural steel base.

#### 2.1.2 Cast Iron Boiler

Boiler shall be of the rectangular, sectional type, self-contained, packaged type, complete with accessories, mounted on a structural steel base. Cast iron sections shall be free of leaks under all operating conditions. Access shall be provided to permit cleaning of internal tube surfaces.

#### 2.1.3 Modular Configuration

Modular boilers shall be of the cast iron type. Modular boilers shall have the capability of independent operation. Upon failure of any module, the remaining modules shall be capable of operating at their designed capacity. The size of the individual modules shall be as indicated.

#### 2.1.4 Hot Water Heating Boilers

The hot water heating boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. The boiler design conditions shall be as follows and as scheduled on the plans:

a. Boiler design pressure 345 kPa.

b. Operating pressure at boiler outlet 200 kPa.

c. Site elevation 546 m.

d. Boilers with a capacity less than 90 kW shall have an Annual Fuel Utilization Efficiency of at least 80 percent. Gas fired boilers with a capacity of greater than or equal to 90 kW shall have a thermal efficiency of at least 80 percent when fired at the maximum and minimum ratings allowed by the controls.

2.2 FUEL BURNING EQUIPMENT

Boiler shall be designed to burn gas. Each boiler shall comply with Federal, state, and local emission regulations. As a minimum, the following emission requirements shall be met:

NOx - parts per million (ppm) corrected to 3% 02.

SO2 - parts per million (ppm) corrected to 3% 02.

Particulate - parts per million (ppm) corrected to 3% 02.

2.2.1 Burners

2.2.2 Draft Fans

Fans conforming to AMCA 801 forced-draft shall be furnished as an integral part of boiler design. Fans shall be centrifugal with backward-curved blades or axial flow type. Each fan shall be sized for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Noise levels for fans shall not exceed 85 decibels in any octave band at a .914 meters (3 foot) station. Forced draft fan bearings shall be air cooled.

2.2.2.1 Draft Fan Control

Forced-draft centrifugal fans shall have inlet vane controls or shall have variable speed control where indicated. Inlet vanes shall be suitable for use with combustion control equipment. Axial propeller fans shall have variable propeller pitch control.

2.2.2.2 Draft Fan Drives

Fans shall be driven by electric motors. Electric motor shall be drip proof. Motor starter shall be magnetic across-the-line type with general purpose enclosure and shall be furnished with four auxiliary interlock contacts.

2.2.3 Draft Damper

Boilers shall be provided with automatic dampers, draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler. Draft damper shall be provided in a convenient and accessible location in the flue gas outlet from the boiler. Automatic damper shall be arranged for automatic operation by means of a damper regulator.

## 2.3 COMBUSTION CONTROL EQUIPMENT

Combustion control equipment shall be provided as a system by a single manufacturer. Field installed automatic combustion control system shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. The boiler water temperature shall be controlled by a water temperature controller. The equipment shall operate either electrically or pneumatically. On multiple boiler installations, each boiler unit shall have a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, a 1 year supply of ink and 400 blank charts for each recorder shall be furnished.

### 2.3.1 Electrical controls

Electrical control devices shall be rated at 120 volts and shall be connected as specified in Section 16415A ELECTRICAL WORK, INTERIOR.

### 2.3.2 Water Temperature Controller

The controller shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed in the boiler return piping. Modulating controllers shall control the fuel burning equipment to maintain set boiler water temperature within 2 percent. Controller shall be furnished with necessary equipment to automatically adjust the setting to suit the outside weather conditions. The outside air reset controller shall be operated in such a manner that the operating temperatures required by the boiler manufacturer are not compromised.

### 2.3.3 Boiler Plant Master Controller

A boiler plant master controller, sensitive to a temperature transmitter in the return water header for the boiler shall be furnished to provide anticipatory signals to all boiler controllers. Boiler controllers shall react to anticipatory signals from the plant master controller as necessary in response to the boiler temperature indication to maintain the preset temperature. An automatic-manual switch shall be provided to allow the sequence of boiler loading to be varied to distribute equal firing time on all boilers in the plant. The plant master controller shall load the boilers one at a time as the plant load increases.

### 2.3.4 Boiler Combustion Controls and Positioners

a. GasModulating combustion controls with gas pilot or spark ignition. Modulating controls shall be provided with a means for manually controlling the firing rate.

b. Modulating control function shall be accomplished using positioning type controls. Air flow ratio and fuel control valve shall be controlled by relative positions of operative levers on a jackshaft responding to a water temperature controller. Positioning type combustion control equipment shall include draft controls with synchronized fuel feed and combustion air supply controls, while and shall maintain the proper air/fuel ratio. The desired furnace draft shall be maintained within 0.01 inch of water column.

2.3.5 Combustion Safety Controls and Equipment

Combustion safety controls and equipment shall be UL listed, microprocessor-based distributed process controller. The system shall include mounting hardware, wiring and cables, and associated equipment. The controller shall be mounted completely wired, programmed, debugged, and tested to perform all of its functions. The controller shall process the signals for complete control and monitoring of the boiler. This shall include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program shall be documented and include cross references in description of coils and contacts. Microprocessor shall be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers for each boiler shall be mounted on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Control systems and safety devices for automatically fired boilers shall conform to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz and shall be connected as specified in Section 16415A ELECTRICAL WORK, INTERIOR. A 100 mm diameter alarm bell shall be provided and shall be located where indicated or directed. The alarm bell shall ring when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure, and a green light shall indicate that the main fuel valve is open. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:

a. Flame failure.

b. Failure to establish pilot flame.

c. Failure to establish main flame.

d. Low-water cutoff.

e. High temperature cutoff.

2.3.5.1 Low-water Cutoff

Low water cutoff shall be float actuated switch or electrically actuated probe type low-water cutoff. Float chamber shall be provided with a blow-down connection. Cutoff shall cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water shall require manual reset before operation can be resumed and shall prevent recycling of the burner. The cutoff shall be in strict accordance to the latest version of code,ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers.

a. Feedwater Regulator with Low-Water Cutoff: Regulator shall be an approved design sized for the application. A regulator shall be provided for each boiler. The feeder shall be so arranged that water will be fed to the boiler automatically when the water level in the boiler drops below a preset point and will actuate the alarm bell when the water level reaches the low danger point. The boiler feeder shall be arranged so that the burner and forced-draft fan will stop whenever the water level drops below a preset danger point. The boiler feeder shall be constructed so that the feedwater valve and seat are isolated from the float chamber to prevent overheating of the feed water and precipitation of scale on either the valve or seat. Each float mechanism, valve, and seat shall be constructed of an approved, durable, corrosion-resistant steel alloy. Valve seats shall be removable and renewable. The regulator shall be equipped with a large, self-cleaning strainer. The drain valve on the regulator shall be the gate or other straight-through type.

2.3.5.2 Water Flow Interlock

Hot water boiler limit controls shall be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls shall not allow boiler startup unless hot water flow is proven.

2.4 PUMPS

2.4.1 Hot Water and Boiler Circulating Pumps

Circulating pumps for hot water shall be electrically driven single-stage centrifugal type and have a capacity not less than indicated. Boiler circulating pumps shall be supported by the piping on which installed and shall be closed-coupled shaft. Hot water circulating pumps shall be supported on a concrete foundation with a cast iron or structural steel base and shall have a flexible-coupled shaft. The hot water circulating pumps shall be base mounted end suction type. The pump shaft shall be constructed of corrosion-resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. Pump seals shall be capable of withstanding 115 degrees C temperature without external cooling. The motor shall have sufficient power for the service required, shall be of a type approved by the manufacturer of the pump, shall be suitable for the available electric service, and shall conform to the requirements of paragraph ELECTRICAL EQUIPMENT. Each pump suction and discharge connection shall be provided with a pressure gauge as specified. The boiler and hot water circulating pump discharge heater shall be provided with a flow switch. Flow switch unit shall be a self-contained swinging vane type to indicate fluid flow. Switch shall be a SPDT with 120-volt, 15-ampere rating.

## 2.5 COLD WATER CONNECTIONS

Connections shall be provided which includes consecutively in line a strainer, backflow prevention device, and water pressure regulator in that order in the direction of the flow. The backflow prevention device shall be provided as indicated and in compliance with Section 15400A PLUMBING, GENERAL PURPOSE. Cold water fill connections shall be made to the water supply system as indicated. Necessary pipe, fittings, and valves required for water connections between the boiler and cold water main shall be provided as shown. The pressure regulating valve shall be of a type that will not stick or allow pressure to build up on the low side. The valve shall be set to maintain a terminal pressure of approximately,lately 35 kPa in excess of the static head on the system and shall operate within a 15 kPa tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

## 2.6 RADIATORS AND CONVECTORS

Radiators, convectors and associated equipment shall be in accordance with Section 15556A FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS.

## 2.7 HEATING AND VENTILATING UNITS

Heating and ventilating units and associated equipment shall be in accordance with Section 15895A AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 2.8 AIR HANDLING UNITS

Air handling units and associated equipment shall be in accordance with Section 15895A AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 2.9 FITTINGS AND ACCESSORIES

Boiler fittings and accessories shall be installed with each boiler in accordance with ASME BPVC SEC IV, unless otherwise specified.

### 2.9.1 Conventional Breeching and Stacks

#### 2.9.1.1 Stacks

Individual stub stacks shall extend above the roof to the heights indicated. Individual stub stacks shall be 6 m in height when assembled on the boiler and measured from the ground line. Stack section shall be sheet steel having a thickness of not less than 2.47 mm. Prefabricated double wall stacks system shall extend above the roof to the height indicated. The stacks shall be 6 m in height when assembled on the boiler and measured from the ground line. The inner stack shall be 304 stainless steel having a thickness of not less than 0.89 mm. The outer stack shall be sheet steel having a thickness of not less than 0.635 mm. A method of maintaining concentricity between the inner and outer stacks shall be incorporated. The joints between the stack sections shall be sealed to prevent flue gas leakage. A 7.92 mm diameter hole shall be provided in the stack not greater than 150 mm from the furnace flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each stack shall be provided complete with rain hood. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. Stack shall be in accordance with UL 1738.

#### 2.9.2 Expansion Tank

The hot water pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. The sizes shall be as indicated. The expansion tank shall be welded steel, constructed, tested, and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 850 kPa (125 psi) and precharged to the minimum operating pressure. The tank's air chamber shall be fitted with an air charging valve and pressure gauge. The tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The tank shall have lifting rings and a drain connection. All components shall be suitable for a maximum operating temperature of 120 degrees C.

#### 2.9.3 Air Separator

External air separation tank shall be steel, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 850 kPa (125 psi). The capacity of the air separation tank indicated is minimum.

#### 2.9.4 Filters

Filters shall conform to ASTM F 872 or CID A-A-1419.

#### 2.9.5 Foundation (Setting) Materials

##### 2.9.5.1 Firebrick

Firebrick shall be ASTM C 27 class as recommended by boiler manufacturer.

##### 2.9.5.2 Tile

Tile shall be ASTM C 34, Grade LBX.

##### 2.9.5.3 Insulating Brick

Insulating brick shall comply with ASTM C 155.

2.9.5.4 Refractory Mortar

Refractory mortar shall comply with ASTM F 1097.

2.9.5.5 Castable Refractories

Castable refractories shall be ASTM C 401. The minimum modulus of rupture for transverse strength shall be not less than 4136 kPa (600 psi) after being heat soaked for 5 hours or more at a temperature in excess of 1371.1 degrees C.

2.9.6 Steel Sheets

2.9.6.1 Galvanized Steel

Galvanized steel shall be ASTM A 653/A 653M.

2.9.6.2 Uncoated Steel

Uncoated steel shall be ASTM A 366/A 366M, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to manufacturer's standard gauge.

2.9.7 Gaskets

Gaskets shall be nonasbestos material in accordance with ASME B16.21, full face or self-centering type. The gaskets shall be of the spiral wound type with graphite filler material.

2.9.8 Steel Pipe and Fittings

2.9.8.1 Steel Pipe

Steel pipe shall be ASTM A 53/A 53M, Type E or S, Grade A or B, black steel, standard weight.

2.9.8.2 Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.9.8.3 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

2.9.8.4 Welded Fittings

Welded fittings shall conform to ASTM A 234/A 234M with WPA marking. Buttwelded fittings shall conform to ASME B16.9, and socket-welded fittings shall conform to ASME B16.11.

2.9.8.5 Cast-Iron Fittings

Fittings shall be ASME B16.4, Class 125, type required to match connecting piping.

2.9.8.6 Malleable-Iron Fittings

Fittings shall be ASME B16.3, type as required to match connecting piping.

2.9.8.7 Unions

Unions shall be ASME B16.39, Class 150.

2.9.8.8 Threads

Pipe threads shall conform to ASME B1.20.1.

2.9.8.9 Grooved Mechanical fittings

Joints and fittings shall be designed for not less than 862 kPa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be ductile iron conforming to ASTM A 536. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 for circulating medium up to 110 degrees C . Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.9.9 Copper Tubing and Fittings

2.9.9.1 Copper Tubing

Tubing shall be ASTM B 88, ASTM B 88M, Type K or L. Adapters for copper tubing shall be brass or bronze for brazed fittings.

2.9.9.2 Solder-Joint Pressure Fittings

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75M . Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18 and ASTM B 828.

2.9.9.3 Flared Fittings

Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62.

2.9.9.4 Adapters

Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.9.9.5 Threaded Fittings

Cast bronze threaded fittings shall conform to ASME B16.15.

2.9.9.6 Brazing Material

Brazing material shall conform to AWS A5.8.

2.9.9.7 Brazing Flux

Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides, and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.

2.9.9.8 Solder Material

Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

2.9.9.9 Solder Flux

Flux shall be either liquid or paste form, non-corrosive and conform to ASTM B 813.

2.9.9.10 Grooved Mechanical Fittings

Joints and fittings shall be designed for not less than 862 kPa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be ductile iron conforming to ASTM A 536. Gaskets shall be molded synthetic rubber with central cavity, pressure responsible configuration and shall conform to ASTM D 2000, for circulating medium up to 110 degrees C . Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.9.10 Dielectric Waterways and Flanges

Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways.

2.9.11 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 861.8 kPa or 1034.2 kPa service. Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, and temperature medium. The flexible section shall be suitable for service intended and may have threaded, welded, soldered, flanged, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.9.12 Pipe Supports

Pipe supports shall conform to MSS SP-58 and MSS SP-69.

2.9.13 Pipe Expansion

2.9.13.1 Expansion Loops

Expansion loops and offsets shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops and offsets shall be cold-sprung and installed where indicated. Pipe guides and anchors shall be provided as indicated.

2.9.13.2 Expansion Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the transverse indicated. The joints shall be designed for a hot water working pressure not less than 862 kPa (125 psig) and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connection shall be flanged. Anchor bases or support bases shall be provided as indicated or required. Sliding surfaces and water wetted surfaces shall be chromium plated or fabricated of corrosion resistant steel. Initial setting shall be made in accordance with the manufacturer's recommendations to compensate for an ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall not be more than 1.5 m from expansion joint, except in lines 100 mm or smaller guides shall be installed not more than 600 mm from the joint. Service outlets shall be provided where indicated.

a. Bellows-type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows-type expansion joints shall conform to the applicable requirements of EJMA Stds and ASME B31.1 with internal lines. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but shall not be less than 1135 kPa.

b. Flexible ball joints shall be constructed of alloys as appropriate for the service intended. The joints shall be threaded, grooved, flanged, or welded end as required and shall be capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Balls and sockets shall be polished, chromium-plated when materials are not of corrosion-resistant steel. The ball type joint shall be designed and constructed in accordance with ASME B31.1 and EJMA Stds. Flanges shall conform to the diameter and drilling of ASME B16.5. Molded gaskets shall be suitable for the service intended.

c. Slip type expansion joints shall be EJMA Stds and ASME B31.1, Class 1 or 2. Type II joints shall be suitable for repacking under full line pressure.

2.9.14 Valves

Valves shall be Class 125 and shall be suitable for the application. Grooved ends per AWWA C606 may be used for water service only. Valves in nonboiler external piping shall meet the material, fabrication and operating requirements of ASME B31.1. The connection type of all valves shall match the same type of connection required for the piping on which installed.

2.9.14.1 Gate Valves

Gate valves 65 mm and smaller shall conform to MSS SP-80 bronze rising stem, threaded, solder, or flanged ends. Gate valves 80 mm (3 inches) and larger shall conform to MSS SP-70 cast iron bronze trim, outside screw and yoke, flanged, or threaded ends.

2.9.14.2 Globe Valves

Globe valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 80 mm and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.9.14.3 Check Valves

Check valves 65 mm and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Check valves 80 mm and larger shall conform to MSS SP-71, cast iron, bronze trim, flanged, or threaded ends.

2.9.14.4 Angle Valves

Angle valves 65 mm and smaller shall conform to MSS SP-80 bronze, threaded, soldered, or flanged ends. Angle valves 80 mm and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.9.14.5 Ball Valves

Ball valves 15 mm and larger shall conform to MSS SP-72, ductile iron or bronze, threaded, soldered, or flanged ends.

2.9.14.6 Plug Valves

Plug valves 51 mm and larger shall conform to MSS SP-78. Plug valves smaller than 51 mm shall conform to ASME B16.34.

2.9.14.7 Grooved End Valves

Valves with grooved ends per AWWA C606 may be used if the valve manufacturer certifies that their performance meets the requirements of the standards indicated for each type of valve.

2.9.14.8 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register the degree of valve opening. Valves shall be calibrated so that flow rate can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves shall be suitable for 120 degrees C temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves, and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

2.9.14.9 Automatic Flow Control Valves

In lieu of the specified balancing valves, automatic flow control valves may be provided to maintain constant flow and shall be designed to be sensitive to pressure differential across the valve to provide the required opening. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 850 kPa or 150 percent of the system operating pressure, whichever is greater. Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, the system pump head capability shall be increased. Valves shall be suitable for 120 degrees C temperature service. Valve materials shall be same as specified for the heating system check, globe, angle, and gate valves. Valve operator shall be the electric motor type or pneumatic type as applicable. Valve operator shall be capable of positive shutoff against the system pump head. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. A portable meter shall be provided with accessory kit as recommended for the project by the automatic valve manufacturer.

2.9.14.10 Butterfly Valves

Butterfly valves shall be 2-flange type or lug wafer type, and shall be bubbletight at 1135 kPa. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze, or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 200 mm shall have throttling handles with a minimum of seven locking positions. Valves 200 mm and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.9.14.11 Drain valves

Drain valves shall be provided at each drain point of blowdown as recommended by the boiler manufacturer. Piping shall conform to ASME BPVC SEC IVand ASTM A 53/A 53M.

2.9.14.12 Safety Valves

Safety valves shall have steel bodies and shall be equipped with corrosion-resistant trim and valve seats. The valves shall be properly guided and shall be positive closing so that no leakage can occur. Adjustment of the desired back-pressure shall cover the range between 15 and 70 kPa. The adjustment shall be made externally, and any shafts extending through the valve body shall be provided with adjustable stuffing boxes having renewable packing. Boiler safety valves of proper size and of the required number, in accordance with ASME BPVC SEC IV, shall be installed so that the discharge will be through piping extended to a location as indicated. Each discharge pipe for hot water service shall be pitched away from the valve seat.

2.9.15 Strainers

Basket and "Y" type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be heavy and durable, fabricated of cast iron, and shall have bottoms drilled and tapped with a gate valve attached for blowdown purposes. Strainers shall be designed for 862 kPa (125 psig) service and 93.3 degrees C (200 degrees F). The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment screen. The screen shall be made of 0.795 mm thick corrosion-resistant steel with small perforations numbering not less than 620,000 per square m to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.9.16 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shutoff valve. Minimum dial size shall be 90 mm. A pressure gauge shall be provided for each boiler in a visible location on the boiler. Pressure gauges shall be provided with readings in Kpa and psi. Pressure gauges shall have an indicating pressure range that is related to the operating pressure of the fluid in accordance with the following table:

| Operating Pressure (kPA) | Pressure Range (kPA) |
|---|---|
| 519-1030 | 0-1400 |
| 105-518 | 0-690 |
| 14-104 | 0-210 (retard) |

| Operating Pressure (psi) | Pressure Range (psi) |
|---|---|
| 76-150 | 0-200 |
| 16-75 | 0-100 |
| 2-15 | 0-30 (retard) |

2.9.17 Thermometers

Thermometers shall be provided with wells and separable corrosion-resistant steel sockets. Mercury shall not be used in thermometers. Thermometers for inlet water and outlet water for each hot water boiler shall be provided in a visible location on the boiler. Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a minimum 225 mm (9 inch) scale. The operating range of the thermometers shall be 0-100 degrees centigrade (32 - 212 degrees Fahrenheit). The thermometers shall be provided with readings in degrees centigrade and Fahrenheit.

2.9.18 Air Vents

2.9.18.1 Manual Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for the pressure rating of the piping system and furnished with threaded plugs or caps.

2.9.18.2 Automatic Air Vents

Automatic air vents shall be 20 mm quick-venting float and vacuum air valves. Each air vent valve shall have a large port permitting the expulsion of the air without developing excessive back pressure, a noncollapsible metal float which will close the valve and prevent the loss of water from the system, an air seal that will effectively close and prevent the re-entry of air into the system when subatmospheric pressures prevail therein, and a thermostatic member that will close the port against the passage of steam from the system. The name of the manufacturer shall be clearly stamped on the outside of each valve. The air vent valve shall be suitable for the pressure rating of the piping system.

2.10 ELECTRICAL EQUIPMENT

Electric motor-driven equipment shall be provided complete with motors, motor starters, and necessary control devices. Electrical equipment, motor control devices, motor efficiencies and wiring shall be as specified in Section 16415A ELECTRICAL WORK, INTERIOR. Motors which are not an integral part of a packaged boiler shall be rated for high efficiency service. Motors which are an integral part of the packaged boiler shall be the highest efficiency available by the manufacturer of the packaged boiler. Motor starters shall be provided complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Starters shall be furnished in general purpose enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices but not shown shall be provided.

2.10.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors 375 W (1/2 hp) and larger shall be three-phase, unless otherwise indicated. Motors shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

2.10.2 Motor Controls

Motor controllers shall be provided complete with properly sized thermal overload protection. Manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Solid state variable speed controllers shall be utilized for fractional through 7.46 kW (10 hp) ratings. Adjustable frequency drives shall be used for larger motors.

2.11 INSULATION

Shop and field-applied insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.12 TOOLS

Special tools shall be furnished. Special tools shall include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Small hand tools shall be furnished within a suitable cabinet, mounted where directed.

2.12.1 Tube Cleaner

If a watertube boiler is being furnished, a water-driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation shall be provided. Tube cleaner and rotary brush shall be provided for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings shall be provided to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

### 2.12.2 Wrenches

Wrenches shall be provided as required for specialty fittings such as manholes, handholes, and cleanouts. One set of extra gaskets shall be provided for all manholes and handholes, for pump barrels, and other similar items of equipment. Gaskets shall be packaged and properly identified.

## 2.13 BOILER WATER TREATMENT

The water treatment system shall be capable of feeding chemicals and bleeding the system to prevent corrosion and scale within the boiler and piping distribution system. The water shall be treated to maintain the conditions recommended by the boiler manufacturer. Chemicals shall meet required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. The services of a company regularly engaged in the treatment of boilers shall be used to determine the correct chemicals and concentrations required for water treatment. The company shall maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Filming amines and proprietary chemicals shall not be used. The water treatment chemicals shall remain stable throughout the operating temperature range of the system and shall be compatible with pump seals and other elements of the system.

### 2.13.1 Boiler Water Limits

The boiler manufacturer shall be consulted for the determination of the boiler water chemical composition limits. The boiler water limits shall be as follows unless dictated differently by the boiler manufacturer's recommendations:

| | |
|---|---|
| Causticity | 20-200 ppm |
| Total Alkalinity (CACO3) | 900-1200 ppm |
| Phosphate | 30-60 ppm |
| Tanin | Medium |
| Dissolved Solids | 3000-5000 ppm |
| Suspended Solids | 300 ppm Max |
| Sodium Sulfite | 20-40 ppm Max |
| Silica | Less than 150 ppm |
| Dissolved Oxygen | Less than 7 ppm |
| Iron | 10 ppm |
| pH (Condensate) | 7 - 8 |
| Sodium Sulfite | 20-40 ppm |
| Hardness | Less than 2 ppm |
| pH | 9.3 - 9.9 |

### 2.13.2 Chemical Shot Feeder

A shot feeder shall be provided as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.13.3 Chemical Piping

The piping and fittings shall be constructed of schedule 80 PVC.

2.13.4 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

## PART 3 EXECUTION

### 3.1 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Boiler and auxiliary equipment shall be installed in accordance with manufacturer's written instructions. Proper provision shall be made for expansion and contraction between boiler foundation and floor. This joint shall be packed with suitable nonasbestos rope and filled with suitable compound that will not become soft at a temperature of 40 degrees C. Boilers and firing equipment shall be supported from the foundations by structural steel completely independent of all brickwork. Boiler supports shall permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching shall be as indicated with full provision for expansion and contraction between all interconnected components.

### 3.2 PIPING INSTALLATION

Unless otherwise specified, nonboiler external pipe and fittings shall conform to the requirements of ASME B31.1. Pipe installed shall be cut accurately to suit field conditions, shall be installed without springing or forcing, and shall properly clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipes shall be free of burrs, oil, grease and other foreign material and shall be installed to permit free expansion and contraction without damaging the building structure, pipe, pipe joints, or pipe supports. Changes in direction shall be made with fittings, except that bending of pipe 100 mm and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be carried through the roof as directed and shall be properly flashed. Unless otherwise indicated, horizontal supply mains shall pitch down in the direction of flow with a grade of not less than 0.2 percent. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unless otherwise specified or shown, final connections to equipment shall be made with malleable-iron unions for steel pipe 65 mm or less in diameter and with flanges for pipe 80 mm or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Reducing fittings shall be used for changes in pipe sizes. In horizontal hot water lines, reducing fittings shall be eccentric type to maintain the top of the lines at the same level to prevent air binding.

### 3.2.1 Hot Water Piping and Fittings

Pipe shall be black steel or copper tubing. Fittings for steel piping shall be black malleable iron or cast iron to suit piping. Fittings adjacent to valves shall suit valve material. Grooved mechanical fittings will not be allowed for water temperatures above 110 degrees C (230 degrees F).

### 3.2.2 Vent Piping and Fittings

Vent piping shall be black steel. Fittings shall be black malleable iron or cast iron to suit piping.

### 3.2.3 Gauge Piping

Piping shall be copper tubing.

### 3.2.4 Joints

Joints between sections of steel pipe and between steel pipe and fittings shall be threaded, grooved, flanged or welded as indicated or specified. Except as otherwise specified, fittings 25 mm and smaller shall be threaded; fittings 32 mm and up to but not including 80 mm shall be either threaded, grooved, or welded; and fittings 80 mm and larger shall be either flanged, grooved, or welded. Pipe and fittings 32 mm and larger installed in inaccessible conduit or trenches beneath concrete floor slabs shall be welded. Connections to equipment shall be made with black malleable-iron unions for pipe 65 mm or smaller in diameter and with flanges for pipe 80 mm inches or larger in diameter. Joints between sections of copper tubing or pipe shall be flared, soldered, or brazed.

#### 3.2.4.1 Threaded Joints

Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.

#### 3.2.4.2 Welded Joints

Welded joints shall be in accordance with paragraph GENERAL REQUIREMENTS unless otherwise specified. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improved flow characteristics where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Socket weld joints shall be assembled so that the space between the end of the pipe and the bottom of the socket is no less than 1.5 mm and no more than 3 mm.

### 3.2.4.3 Grooved Mechanical Joints

Grooved mechanical joints may be provided for hot water systems in lieu of unions, welded, flanged, or screwed piping connections in low temperature hot water systems where the temperature of the circulating medium does not exceed 110 degrees C. Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations. Mechanical joints shall use rigid mechanical pipe couplings, except at equipment connections. At equipment connections, flexible couplings may be used. Coupling shall be of the bolted type for use with grooved end pipes, fittings, valves, and strainers. Couplings shall be self-centering and shall engage in a watertight couple.

### 3.2.4.4 Flared and Brazed Copper Pipe and Tubing

Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver or a silver brazing filler metal. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided in all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Flared or brazed copper tubing to pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing.

### 3.2.4.5 Soldered Joints

Soldered joints shall be made with flux and are only acceptable for lines 50 mm and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.

### 3.2.4.6 Copper Tube Extracted Joint

An extruded mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

3.2.5 Flanges and Unions

Flanges shall be faced true, provided with 1.6 mm thick gaskets, and made square and tight. Where steel flanges mate with cast-iron flanged fittings, valves, or equipment, they shall be provided with flat faces and full face gaskets. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Dielectric pipe unions shall be provided between ferrous and nonferrous piping to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

3.2.6 Branch Connections

3.2.6.1 Branch Connections for Hot Water Systems

Branches from the main shall pitch up or down as shown to prevent air entrapment. Connections shall ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Branches shall pitch with a grade of not less than 8 mm in 1 m. When indicated, special flow fittings shall be installed on the mains to bypass portions of the water through each radiator. Special flow fittings shall be standard catalog products and shall be installed as recommended by the manufacturer.

3.2.7 Flared, Brazed, and Soldered Copper Pipe and Tubing

Copper tubing shall be flared, brazed, or soldered. Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing. Brazed joints shall be made in conformance with MSS SP-73, and CDA Tube Handbook. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver, or a silver brazing filler metal. Soldered joints shall be made with flux and are only acceptable for lines 50 mm or smaller. Soldered joints shall conform to ASME B31.5 and shall be in accordance with CDA Tube Handbook.

### 3.2.8 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

### 3.2.9 Supports

Hangers used to support piping 50 mm and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. Threaded rods which are used for support shall not be formed or bent.

#### 3.2.9.1 Seismic Requirements for Supports and Structural Bracing

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Sections15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided in this section. Material used for supports shall be as specified in Section 05120A STRUCTURAL STEEL.

#### 3.2.9.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe, if the clamp bottom does not extend through the insulation, and if the top clamp attachment does not contact the insulation during pipe movement.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1500 mm apart at valves.

h. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4500 mm, not more than 2400 mm from end of risers, and at vent terminations.

i. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

(1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger, a Type 39 saddle may be welded to the pipe and freely rested on a steel plate. On piping under 100 mm (4 inches), a Type 40 protection shield may be attached to the pipe or insulation and freely rested on a steel slide plate.

(2) Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm or by an amount adequate for the insulation, whichever is greater.

j. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

k. Piping in trenches shall be supported as indicated.

l. Structural steel attachments and brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120A STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist between panel points shall not exceed 22 kg. Loads exceeding 22 kg shall be suspended from panel points.

### 3.2.9.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support member shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run. The clips or clamps shall be rigidly attached to the common base member. A clearance of 3 mm shall be provided between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

### 3.2.10 Anchors

Anchors shall be provided where necessary to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results, using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

### 3.2.11 Valves

Valves shall be installed where indicated, specified, and required for functioning and servicing of the systems. Valves shall be safely accessible. Swing check valves shall be installed upright in horizontal lines and in vertical lines only when flow is in the upward direction. Gate and globe valves shall be installed with stems horizontal or above. Valves to be brazed shall be disassembled prior to brazing and all packing removed. After brazing, the valves shall be allowed to cool before reassembling.

### 3.2.12 Pipe Sleeves

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated where membranes are involved. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof. Sleeves through walls shall be cut flush with wall surface. Sleeves through floors shall be cut flush with floor surface. Sleeves through roofs shall extend above the top surface of roof at least 150 mm for proper flashing or finishing. Unless otherwise indicated, sleeves shall be sized to provide a minimum clearance of 6 mm between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in waterproofing membrane floors, bearing walls, and wet areas shall be galvanized steel pipe or cast-iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls shall be sealed as indicated and specified in Section 07900A JOINT

SEALING. Metal jackets shall be provided over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

a. Metal jackets shall not be thinner than 0.1524 mm (0.006 inch) thick aluminum, if corrugated, and 0.4 mm (0.016 inch) thick aluminum, if smooth.

b. Metal jackets shall be secured with aluminum or stainless steel bands not less than 9 mm wide and not more than 200 mm apart. When penetrating roofs and before fitting the metal jacket into place, a 15 mm wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 1000 mm above the roof. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the back-up material to a minimum distance of 50 mm above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 300 mm above material to a minimum distance of 50 mm above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 300 mm above the floor; when passing through walls above grade, the jacket shall extend at least 100 mm beyond each side of the wall.

3.2.12.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, pipes passing through waterproofing membranes shall be provided with a 1.6 mm lead flashing or a 0.55 mm copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 200 mm from the pipe and shall set over the membrane in a troweled coating of bituminous cement. The flashing shall extend above the roof or floor a minimum of 250 mm. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 250 mm (10 inches) in diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

3.2.12.2 Optional Modular Mechanical Sealing Assembly

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between the sleeve and conduit or pipe in lieu of a waterproofing clamping flange and caulking and sealing specified above. The seals shall include interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.2.12.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 150 mm (6 inches) in diameter, lead flashing sleeve for dry vents with the sleeve turned down into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

3.2.12.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07840A FIRESTOPPING.

3.2.13 Balancing Valves

Balancing valves shall be installed as indicated.

3.2.14 Thermometer Wells

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

3.2.15 Air Vents

Air vents shall be installed where shown or directed. Air vents shall be installed in piping at all system high points. The vent shall remain open until water rises in the tank or pipe to a predetermined level at which time it shall close tight. An overflow pipe from the vent shall be run to a point designated by the Contracting Officer's representative. The inlet to the air vent shall have a gate valve or ball valve.

3.2.16 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrews.

3.2.17 Drains

A drain connection with a 25 mm (1 inch) gate valve or 20 mm (3/4 inch hose bib shall be installed at the lowest point in the return main near the boiler. In addition, threaded drain connections with threaded cap or plug shall be installed on the heat exchanger coil on each unit heater or unit ventilator and wherever required for thorough draining of the system.

3.2.18 Direct Venting for Combustion Intake Air and Exhaust Air

The intake air and exhaust vents shall be installed in accordance with NFPA 54 and boiler manufacturer's recommendations. The exhaust vent shall be sloped 20.8 mm per m (1/4 inch per ft) toward the boiler's flue gas condensate collection point.

## 3.3 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 15190A GAS PIPING SYSTEMS. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL Gas&Oil Dir. The fuel system shall be provided with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves shall be provided.

## 3.4 COLOR CODE MARKING AND FIELD PAINTING

Color code marking of piping shall be as specified in Section {AM#0001}15075 {AM#0001}IDENTIFICATION OF PIPING. Ferrous metal not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in Section 09900 PAINTING, GENERAL. Exposed pipe covering shall be painted as specified in Section 09900 PAINTING, GENERAL. Aluminum sheath over insulation shall not be painted.

## 3.5 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall be tested in accordance with Section 15400A PLUMBING, GENERAL PURPOSE.

## 3.6 HEATING SYSTEM TESTS

Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units shall be hydrostatically tested and proved tight at a pressure of 1-1/2 times the design working pressure, but not less than 689 kPa. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure shall be blanked off or replaced with spool pieces. Before balancing and final operating test, test blanks and spool pieces shall be removed; and protected instruments and equipment shall be reconnected. With equipment items protected, the system shall be pressurized to test pressure. Pressure shall be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks shall be repaired and repaired joints shall be retested. Upon completion of hydrostatic tests and before acceptance of the installation, the Contractor shall balance the heating system in accordance with Section 15990A TESTING, ADJUSTING, AND BALANCING

OF HVAC SYSTEMS; and operating tests required to demonstrate satisfactory functional and operational efficiency shall be performed. The operating test shall cover a period of at least 24 hours for each system, and shall include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

a. Certification of balancing.

b. Time, date, and duration of test.

c. Outside and inside dry bulb temperatures.

d. Temperature of hot water supply leaving boiler.

e. Temperature of heating return water from system atboiler inlet.

f. Quantity of water feed to boiler.

g. Boiler make, type, serial number, design pressure, and rated capacity.

h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.

i. Circulating pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.

j. Flue-gas temperature at boiler outlet.

k. Percent carbon dioxide in flue-gas.

l. Grade or type and calorific value of fuel.

m. Draft at boiler flue-gas exit.

n. Draft or pressure in furnace.

o. Quantity of water circulated.

p. Quantity of fuel consumed.

q. Stack emission pollutants concentration.

Indicating instruments shall be read at half-hour intervals unless otherwise directed. The Contractor shall furnish all instruments, equipment, and personnel required for the tests and balancing. Fuels, water, and electricity shall be obtained as specified in the SPECIAL CONTRACT REQUIREMENTS. Operating tests shall demonstrate that fuel burners and combustion and safety controls meet the requirements of ASME CSD-1, ANSI Z21.13, NFPA 8501.

3.6.1 Water Treatment Testing

3.6.1.1 Water Quality Test

The boiler water shall be analyzed prior to the acceptance of the facility by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

| | |
|---|---|
| Date of Sample | _____ |
| Temperature | _____ degrees C |
| Silica (SiO2) | _____ ppm (mg/1) |
| Insoluble | _____ ppm (mg/1) |
| Iron and Aluminum Oxides | _____ ppm (mg/1) |
| Calcium (Ca) | _____ ppm (mg/1) |
| Magnesium (Mg) | _____ ppm (mg/1) |
| Sodium and Potassium (Na and K) | _____ ppm (mg/1) |
| Carbonate (HCO3) | _____ ppm (mg/1) |
| Sulfate (SO4) | _____ ppm (mg/1) |
| Chloride (C1) | _____ ppm (mg/1) |
| Nitrate (NO3) | _____ ppm (mg/1) |
| Turbidity | _____ unit |
| pH | _____ |
| Residual Chlorine | _____ ppm (mg/1) |
| Total Alkalinity | _____ epm (meq/1) |
| Noncarbonate Hardness | _____ epm (meq/1) |
| Total Hardness | _____ epm (meq/1) |
| Dissolved Solids | _____ ppm (mg/1) |
| Fluorine | _____ ppm (mg/1) |
| Conductivity | _____ micro-mho/cm |

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company shall take corrective action.

3.6.1.2 Boiler/Piping Test

At the conclusion of the 1 year period, the boiler and condensate piping shall be inspected for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, proper repairs shall be made by the water treatment company.

3.7 CLEANING

3.7.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the boilers and feed water piping shall be thoroughly cleaned by filling the system with a solution consisting of either 0.5 kg of caustic soda or 0.5 kg of trisodium phosphate per 100 L of water. The proper safety precautions shall be observed in the handling and use of these chemicals. The water shall be heated to approximately 65 degrees C and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water. Strainers and valves shall be thoroughly cleaned. Prior to operating tests, air shall be removed from all water systems by operating the air vents.

#### 3.7.2 Heating Units

Inside space heating equipment, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for fans that are operated during construction, and new filters shall be installed after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.8 FUEL SYSTEM TESTS

#### 3.8.1 Gas System Test

The gas fuel system shall be tested in accordance with the test procedures outlined in NFPA 54.

### 3.9 FIELD TRAINING

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance instructions, as well as demonstrations of routine maintenance operations and boiler safety devices. The Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

-- End of Section --

# SECTION 15620

# LIQUID CHILLERS
**12/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

| | |
|---|---|
| ARI 495 | (1999) Refrigerant Liquid Receivers |
| ARI 550/590 | (1998) Water-Chilling Packages Using the Vapor Compression Cycle |
| ARI 700 | (1999) Specifications for Fluorocarbon and Other Refrigerants |

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

| | |
|---|---|
| ABMA 11 | (1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings |
| ABMA 9 | (1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM B 117 | (1997) Operating Salt Spray (Fog) Apparatus |
| ASTM D 520 | (2000) Zinc Dust Pigment |
| ASTM E 84 | (2001) Surface Burning Characteristics of Building Materials |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 15 | (1994) Safety Code for Mechanical Refrigeration |
| ASHRAE 34 | (1997) Number Designation and Safety Classification of Refrigerants |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS Z49.1 | (1999) Safety in Welding and Cutting |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME BPVC SEC IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |
| ASME BPVC SEC VIII D1 | (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (1998) Motors and Generators |
| NEMA MG 2 | (1989) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators |

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings.

Drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and all interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

SD-03 Product Data

Refrigeration System; G, ED.

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be adequate to demonstrate compliance with contract requirements as specified within the paragraphs:

a. Liquid Chiller

b. Chiller Components

c. Accessories

If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

Spare Parts.

Spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

Posted Instructions.

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

Verification of Dimensions; G, RE.

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

Manufacturer's Multi-Year Compressor Warranty.

Manufacturer's multi-year warranty for compressor(s) in air-cooled liquid chillers as specified.

System Performance Tests.

A schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules shall identify the proposed date, time, and location for each test.

Demonstrations

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

SD-06 Test Reports

Factory Tests

Six copies of the report shall be provided in bound 216 x 279 mm (8 1/2 x 11 inch) booklets. Reports shall certify the compliance with performance requirements and follow the format of the required testing standard for both the Chiller Performance Tests and the Chiller Sound Tests. Test report shall include certified calibration report of all test instrumentation. Calibration report shall include certification that all test instrumentation has been calibrated within 6 months prior to the test date, identification of all instrumentation, and certification that all instrumentation complies with requirements of the test standard. Test report shall be submitted 1 week after completion of the factory test.

System Performance Tests.

Six copies of the report shall be provided in bound 216 x 279 (8 1/2 x 11 inch) booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C (5 degrees F) apart:

a. Date and outside weather conditions.

b. The load on the system based on the following:

(1) The refrigerant used in the system.
(2) Condensing temperature and pressure.
(3) Suction temperature and pressure.
(4) For absorption units, the cooling water pressures and temperatures entering and exiting the absorber and condenser.

Also the refrigerant solution pressures, concentrations, and temperatures at each measurable point within the system.

(5) Running current, voltage and proper phase sequence for each phase of all motors.

(6) The actual on-site setting of all operating and safety controls.

(7) Chilled water pressure, flow and temperature in and out of the chiller.

(8) The position of the capacity-reduction gear at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

SD-07 Certificates

Refrigeration System.

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, 2 copies of proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

Service Organization.

A certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

SD-10 Operation and Maintenance Data

Operation Manuals; G, RE.

Six complete copies of an operation manual in bound 216 x 279 (81/2 x 11 inch) booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manuals; G, RE.

Six complete copies of maintenance manual in bound 216 x 279 (81/2 x 11 inch) booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

## 1.3 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

## 1.5 PROJECT/SITE CONDITIONS

### 1.5.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

### 1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

## 1.6 MANUFACTURER'S MULTI-YEAR COMPRESSOR WARRANTY

The Contractor shall provide a 5 year parts only (excludes refrigerant) manufacturer's warranty on the air-cooled chiller compressor(s). This warranty shall be directly from the chiller manufacturer to the Government and shall be in addition to the standard one-year warranty of construction. The manufacturer's warranty shall provide for the repair or replacement of the chiller compressor(s) that become inoperative as a result of defects in material or workmanship within 5 years after the date of final acceptance. When the manufacturer determines that a compressor requires replacement, the manufacturer shall furnish new compressor(s) at no additional cost to the Government. Upon notification that a chiller compressor has failed under the terms of the warranty, the manufacturer shall respond in no more than 24 hours. Response shall mean having a manufacturer-qualified technician onsite to evaluate the extent of the needed repairs. The warranty period shall begin on the same date as final acceptance and shall continue for the full product warranty period.

1.6.1 Indexed Notebook

The Contractor shall furnish to the Contracting Officer a bound and indexed notebook containing a complete listing of all air-cooled liquid chillers covered by a manufacturer's multi-year warranty. The chiller list shall state the duration of the warranty thereof, start date of the warranty, ending date of the warranty, location of the warranted equipment, and the point of contact for fulfillment of the warranty. Point of contact shall include the name of the service representative along with the day, night, weekend, and holiday phone numbers for a service call. The completed bound and indexed notebook shall be delivered to the Contracting Office prior to final acceptance of the facility.

1.6.2 Local Service Representative

The Contractor shall furnish with each manufacturer's multi-year warranty the name, address, and telephone number (day, night, weekend, and holiday) of the service representative nearest to the location where the equipment is installed. Upon a request for service under the multi-year warranty, the service representative shall honor the warranty during the warranty period, and shall provide the services prescribed by the terms of the warranty.

1.6.3 Equipment Warranty Tags

At the time of installation, each item of manufacturer's multi-year warranted equipment shall be tagged with a durable, oil- and water-resistant tag, suitable for interior and exterior locations, resistant to solvents, abrasion, and fading due to sunlight. The tag shall be attached with copper wire or a permanent, pressure-sensitive, adhesive backing. The tag shall be installed in an easily noticed location attached to the warranted equipment. The tag for this equipment shall be similar to the following in format, and shall contain all of the listed information:

MANUFACTURER'S MULTI-YEAR WARRANTY EQUIPMENT TAG
Equipment/Product Covered: ____________________
Manufacturer:_______Model No.:_____Serial No.:__
Warranty Period: From _________to _____________
Contract No.: _________________________________
Warranty Contact: _____________________________
Name: _________________________________________
Address: ______________________________________
Telephone: ____________________________________
STATION PERSONNEL SHALL PERFORM PREVENTIVE

MAINTENANCE AND OPERATIONAL MAINTENANCE

## PART 2 PRODUCTS

### 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

### 2.2 NAMEPLATES

Major equipment including chillers, compressors, compressor drivers, condensers, liquid coolers, receivers, refrigerant leak detectors, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum . Plates shall be fixed in prominent locations with nonferrous screws or bolts.

### 2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 746 kW (1 hp) and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.4 SELF-CONTAINED LIQUID CHILLER

Unless necessary for delivery purposes, units shall be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unit components delivered separately shall be sealed and charged with a nitrogen holding charge. Unit assembly shall be completed in strict accordance with manufacturer's recommendations. Chiller shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 23 kg or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, shall have lifting eyes or lugs. Chiller shall include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller shall be provided with a single point wiring connection for incoming power supply. Chiller's condenser and liquid cooler shall be provided with standard water boxes with flanged connections.

### 2.4.1 Scroll, Reciprocating, or Rotary Screw Type

Chiller shall be constructed and rated in accordance with ARI 550/590. Chiller shall be conform to ASHRAE 15. Chiller shall have a minimum full load COP rating as scheduled and a part load COP rating in accordance with ARI 550/590. As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

e. Scroll, reciprocating, or rotary screw compressor

f. Compressor driver, electric motor

g. Compressor driver connection

h. Liquid cooler (evaporator)

i. Air-cooled condenser coil

j. Tools

## 2.5 CHILLER COMPONENTS

### 2.5.1 Refrigerant and Oil

Refrigerants shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05.

### 2.5.2 Structural Base

Chiller and individual chiller components shall be provided with a factory-mounted structural steel base (welded or bolted) or support legs. Chiller and individual chiller components shall be isolated from the building structure by means of molded neoprene isolation pads.

### 2.5.3 Chiller Refrigerant Circuit

Chiller refrigerant circuit shall be completely piped and factory leak tested. For multicompressor units, not less than 2 independent refrigerant circuits shall be provided. Circuit shall include as a minimum a combination filter and drier, combination sight glass and moisture indicator, liquid-line solenoid valve for reciprocating, an electronic or thermostatic expansion valve with external equalizer, charging ports, compressor service valves for field-serviceable compressors, and superheat adjustment.

### 2.5.4 Controls Package

Chiller shall be provided with a complete factory-mounted, prewired electric or microprocessor based control system. Controls package shall contain as a minimum a digital display or acceptable gauges, an on-auto-off switch, motor starters, power wiring, and control wiring. Controls package shall provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and EMCS interfaces as defined below.

#### 2.5.4.1 Operating Controls

Chiller shall be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. Adjustable timer or automated controls to prevent a compressor from short cycling

c. Automatic lead/lag controls (adjustable) for multi-compressor units

d. Load limiting

e. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle the chiller on power interruption.

f. Startup and head pressure controls to allow system operation at all ambient temperatures down to -6.7 degrees C

g. Fan sequencing for air-cooled condenser

2.5.4.2 Monitoring Capabilities

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters. Access and operation of display shall not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures

b. Self diagnostic

c. Operation status

d. Operating hours

e. Number of starts

f. Compressor status (on or off)

g. Refrigerant discharge and suction pressures

2.5.4.3 Programmable Setpoints

The control system shall be capable of being reprogrammed directly at the unit. No parameters shall be capable of being changed without first entering a security access code. The programmable setpoints shall include the following as a minimum.

a. Leaving Chilled Water Temperature

b. Time Clock/Calender Date

2.5.4.4 Safety Controls with Manual Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Low chilled water temperature protection

b. High condenser refrigerant discharge pressure protection

c. Low evaporator pressure protection

d. Chilled water flow detection

e. High motor winding temperature protection

f. Low oil flow protection if applicable

2.5.4.5 Safety Controls with Automatic Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

a. Over/under voltage protection

b. Chilled water flow interlock

c. Phase reversal protection

2.5.4.6 Remote Alarm

During the initiation of a safety shutdown, a chiller's control system shall be capable of activating a remote alarm bell. In coordination with the chiller, the contractor shall provide an alarm circuit (including transformer if applicable) and a minimum 100 mm (4 inch) diameter alarm bell. Alarm circuit shall activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell shall not sound for a chiller that uses low-pressure cutout as an operating control.

2.5.4.7 Energy Management Control System (EMCS) Interface

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operating commands.

a. Remote Unit Start/Stop

b. Remote Chilled Water Reset

c. Remote Condenser Water Reset

2.5.5 Compressor(s)

2.5.5.1 Rotary Screw Compressor(s)

Compressors shall operate stably for indefinite time periods at any stage of capacity reduction without hot-gas bypass. Provision shall be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Rotary screw compressors shall include:

a. An open or hermetic, positive displacement, oil-injected design directly driven by the compressor driver. Compressor shall allow access to internal compressor components for repairs, inspection, and replacement of parts.

b. Rotors which are solid steel forging with sufficient rigidity for proper operation.

c. A maximum rotor operating speed no greater than 3600 RPM.

d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors.

e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.

f. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11. Bearings shall be conservatively loaded and rated for an L(10) life of not less than 200,000 hours.

g. A differential oil pressure or flow cutout to allow the compressor to operate only when the required oil pressure or flow is provided to the bearings.

h. A temperature- or pressure-initiated, hydraulically actuated, single-slide-valve, capacity-control system to provide minimum automatic capacity modulation from 100 percent to 15 percent.

i. An oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.

j. Crankcase oil heaters controlled as recommended by the manufacturer.

2.5.6 Compressor Driver, Electric Motor

Motors, starters, , wiring, etc. shall be in accordance with paragraph ELECTRICAL WORK. Motor starter shall be unit mounted as indicated with starter type, wiring, and accessories coordinated with the chiller manufacturer. Starter shall be able to operate in temperatures up to 120 degrees F.

2.5.7 Compressor Driver Connections

Each compressor shall be driven by a V-belt drive or direct connected through a flexible coupling, except that flexible coupling is not required on hermetic units. V-belt drives shall be designed for not less than 150 percent of the driving motor capacity. Flexible couplings shall be of the type that does not require lubrication.

2.5.8 Liquid Cooler (Evaporator)

Cooler shall be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than 1,000 kPa . Cooler shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Performance shall be based on a water velocity not less than 0.91 m/s (3 fps) nor more than 3.7 mm (12 fps) and a fouling factor of .00002.

### 2.5.9 Air-Cooled Condenser Coil

Condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless copper or aluminum tubes with compatible copper or aluminum fins. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 3 degrees C subcooling and full pumpdown capacity. Coil shall be factory leak and pressure tested after assembly in accordance with ASHRAE 15.

### 2.5.10 Receivers

Liquid receivers not already specified herein as an integral factory-mounted part of a package, shall be designed, fitted, and rated in accordance with the recommendations of ARI 495, except as modified herein. Receiver shall bear a stamp certifying compliance with ASME BPVC SEC VIII D1 and shall meet the requirements of ASHRAE 15. Inner surfaces shall be thoroughly cleaned by sandblasting or other approved means. Each receiver shall have a storage capacity not less than 20 percent in excess of that required for the fully-charged system. Each receiver shall be equipped with inlet, outlet drop pipe, drain plug, purging valve, relief valves of capacity and setting required by ASHRAE 15, and two bull's eye liquid-level sight glasses. Sight glasses shall be in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 75 mm horizontally from the drop pipe measured along the axis of the receiver. In lieu of bull's eye sight glass, external gauge glass with metal glass guard and automatic closing stop valves may be provided.

### 2.5.11 Tools

One complete set of special tools, as recommended by the manufacturer for field maintenance of the system, shall be provided. Tools shall be mounted on a tool board in the equipment room or contained in a toolbox as directed by the Contracting Officer.

## 2.6 FABRICATION

### 2.6.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

### 2.6.2 Factory Applied Insulation

Chiller shall be provided with factory installed insulation on surfaces subject to sweating including the liquid cooler, suction line piping, economizer, and cooling lines. Insulation on heads of coolers may be field applied, however it shall be installed to provide easy removal and replacement of heads without damage to the insulation. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

## 2.7 FACTORY TESTS

### 2.7.1 Chiller Performance Test

The Contractor and proposed chiller manufacturer shall be responsible for performing the chiller factory test to validate the specified full load capacity, full load EER, and IPLV in accordance with ARI 550/590 except as indicated. The Contractor and chiller manufacturer shall provide to the Government a certified chiller factory test report in accordance with ARI 550/590 to confirm that the chiller performs as specified. Tests shall be conducted in an ARI certified test facility in conformance with ARI 550/590 procedures and tolerances, except as indicated. At a minimum, chiller capacity shall be validated to meet the scheduled requirements indicated on the drawings. Tolerance or deviation shall be in strict accordance with ARI 550/590. Stable operation at minimum load of 10 percent of total capacity shall be demonstrated during the factory test.

#### 2.7.1.1 Temperature Adjustments

Temperature adjustments shall adhere to ARI 550/590 to adjust from the design fouling factor to the clean tube condition. Test temperature adjustments shall be verified prior to testing by the manufacturer. There shall be no exceptions to conducting the test with clean tubes with the temperature adjustments per ARI 550/590. The manufacturer shall clean the tubes, if necessary, prior to testing to obtain a test fouling factor of 0.0000.

#### 2.7.1.2 Test Instrumentation

The factory test instrumentation shall be per ARI 550/590 and the calibration shall be traceable to the National Institute of Standards and Technology.

2.7.1.3 Equipment Adjustments

If the equipment fails to perform within allowable tolerances, the manufacturer shall be allowed to make necessary revisions to his equipment and retest as required. The manufacturer shall assume all expenses incurred by the Government to witness the retest.

2.8 SUPPLEMENTAL COMPONENTS/SERVICES

2.8.1 Chilled and Condenser Water Piping and Accessories

Chilled and condenser water piping and accessories shall be provided and installed in accordance with Section 15181A CHILLED AND CONDENSER WATER PIPING AND ACCESSORIES.

2.8.2 {AM#0001}DELETED

2.8.3 Cooling Tower

Cooling towers shall be provided and installed in accordance with Section 15645A COOLING TOWER.

2.8.4 Temperature Controls

Chiller control packages shall be fully coordinated with and integrated into the temperature control system specified in Section HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS and 15952 DIRECT DIGITAL CONTROL SYSTEM FOR DYESS AFB..

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPV IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.1.1 Refrigeration System

3.1.1.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, liquid coolers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 150 mm concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to 20 percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.1.2 Field Refrigerant Charging

a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system shall be broken by adding the required charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor shall provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system shall be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points shall be installed and tightened.

b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant shall be pumped into the system receiver or other suitable container. The refrigerant shall not be discharged into the atmosphere.

c. Contractor's Responsibility: The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 85 g of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.1.1.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

#### 3.1.2 Field Applied Insulation

Field installed insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

#### 3.1.3 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

### 3.2 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for 2 days. The representative shall advise on the following:

a. Hermetic machines:

   (1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 microns.

   (2) Charging the machine with refrigerant.

   (3) Starting the machine.

b. Open Machines:

   (1) Erection, alignment, testing, and dehydrating.

   (2) Charging the machine with refrigerant.

   (3) Starting the machine.

### 3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

### 3.4 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. Field tests shall be coordinated with Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

## 3.5 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

# SECTION 15895

## AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM
**02/94**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

| | |
|---|---|
| ARI 410 | (1991) Forced-Circulation Air-Cooling and Air-Heating Coils |
| ARI 430 | (1989) Central-Station Air-Handling Units |
| ARI 880 | (1998) Air Terminals |
| ARI Guideline D | (1996) Application and Installation of Central Station Air-Handling Units |

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

| | |
|---|---|
| AMCA 210 | (1985) Laboratory Methods of Testing Fans for Rating |
| AMCA 300 | (1996) Reverberant Room Method for Sound Testing of Fans |

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

| | |
|---|---|
| AFBMA Std 9 | (1990) Load Ratings and Fatigue Life for Ball Bearings |
| AFBMA Std 11 | (1990) Load Ratings and Fatigue Life for Roller Bearings |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 47/A 47M | (1999) Ferritic Malleable Iron Castings |
| ASTM A 53/A 53M | (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 106 | (1999el) Seamless Carbon Steel Pipe for High-Temperature Service |

| | |
|---|---|
| ASTM A 123/A 123M | (1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 167 | (1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A 181/A 181M | (1995b) Carbon Steel Forgings, for General-Purpose Piping |
| ASTM A 183 | (1998) Carbon Steel Track Bolts and Nuts |
| ASTM A 193/A 193M | (2000) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A 234/A 234M | (2001a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A 536 | (1999el) Ductile Iron Castings |
| ASTM A 733 | (1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples |
| ASTM A 924/A 924M | (1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B 62 | (1993) Composition Bronze or Ounce Metal Castings |
| ASTM B 75 | (1999) Seamless Copper Tube |
| ASTM B 88 | (1999) Seamless Copper Water Tube |
| ASTM B 88M | (1999) Seamless Copper Water Tube (Metric) |
| ASTM B 117 | (1997) Operating Salt Spray (Fog) Apparatus |
| ASTM B 650 | (1995) Electrodeposited Engineering Chromium Coatings of Ferrous Substrates |
| ASTM B 813 | (2000) Liquid and Paste Fluxes for Soldering Applications for Copper and Copper Alloy Tube |
| ASTM C 916 | (1985; R 1996el) Adhesives for Duct Thermal Insulation |
| ASTM C 1071 | (1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material) |

| | |
|---|---|
| ASTM D 520 | (2000) Zinc Dust Pigment |
| ASTM D 1654 | (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments |
| ASTM D 2000 | (1999) Rubber Products in Automotive Applications |
| ASTM D 3359 | (1997) Measuring Adhesion by Tape Test |
| ASTM E 84 | (2001) Surface Burning Characteristics of Building Materials |
| ASTM E 437 | (1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series) |
| ASTM F 1199 | (1988; R 1998) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum) |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 52.1 | (1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter |
| ASHRAE 68 | (1986) Laboratory Method of Testing In-Duct Sound Power Measurement Procedures for Fans |
| ASHRAE 70 | (1991) Method of Testing for Rating the Performance of Air Outlets and Inlets |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B1.20.1 | (1983; R 1992) Pipe Threads, General Purpose (Inch) |
| ASME B16.3 | (1998) Malleable Iron Threaded Fittings |
| ASME B16.5 | (1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24 |
| ASME B16.9 | (1993) Factory-Made Wrought Steel Buttwelding Fittings |
| ASME B16.11 | (1996) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.18 | (1984; R 1994) Cast Copper Alloy Solder |

| | |
|---|---|
| | Joint Pressure Fittings |
| ASME B16.21 | (1992) Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.22 | (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (1988) Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.39 | (1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300 |
| ASME B31.1 | (1998) Power Piping |
| ASME B40.1 | (1991) Gauges - Pressure Indicating Dial Type - Elastic Element |
| ASME BPV IX | (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C606 | (1997) Grooved and Shouldered Joints |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1 | (2000) Structural Welding Code - Steel |

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

| | |
|---|---|
| EJMA Stds | (1998; 7th Edition) EJMA Standards |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-25 | (1998) Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-58 | (1993) Pipe Hangers and Supports - Materials, Design and Manufacture |
| MSS SP-69 | (1996) Pipe Hangers and Supports - Selection and Application |
| MSS SP-70 | (1998) Cast Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-71 | (1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends |
| MSS SP-72 | (1999) Ball Valves with Flanged or |

| | |
|---|---|
| | Butt-Welding Ends for General Service |
| MSS SP-80 | (1997) Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-85 | (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends |
| MSS SP-110 | (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (1998) Motors and Generators |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | (1999) Installation of Air Conditioning and Ventilating Systems |

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA HVAC Duct Const Stds | (1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible |
| SMACNA Install Fire Damp HVAC | (1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems |
| SMACNA Leakage Test Mnl | (1985) HVAC Air Duct Leakage Test Manual |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 181 | (1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors |
| UL 214 | (1997) Tests for Flame-Propagation of Fabrics and Films |
| UL 5555 | (2002) Fire Dampers |
| UL 586 | (1996; Rev thru Aug 1999) High-Efficiency, Particulate, Air Filter Units |
| UL 723 | (1996; Rev thru Dec 1998) Test for Surface Burning Characteristics of Building Materials |
| UL 900 | (1994; Rev thru Nov 1999) Test Performance of Air Filter Units |
| UL Bld Mat Dir | (1999) Building Materials Directory |

| | |
|---|---|
| UL Elec Const Dir | (1999) Electrical Construction Equipment Directory |
| UL Fire Resist Dir | (1999) Fire Resistance Directory (2 Vol.) |

## 1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

## 1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings.
Installation.

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-03 Product Data

Components and Equipment; G, ED

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

a. Piping Components

b. Ductwork Components

c. Air Systems Equipment

d. Air Handling Units

e. Energy Recovery Devices

f. Terminal Units

Test Procedures.

Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures; G, RE.

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; G, ED.

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

Welding Joints.

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

Testing, Adjusting and Balancing.

Proposed test schedules for hydrostatic test of piping, ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training.

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-06 Test Reports

Performance Tests.

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results. {AM#0001}Provide TAB company letter of approval with all submittals.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, RE.

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

### 2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

### 2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

### 2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

## 2.5 PIPING COMPONENTS

### 2.5.1 Steel Pipe

Steel pipe shall conform to ASTM A 53/A 53M, Schedule 40, Grade A or B, Type E or S.

### 2.5.2 Joints and Fittings For Steel Pipe

Joints shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 25 mm (1 inch) and smaller shall be threaded; piping larger than 25 mm (1 inch) and smaller than 80 mm (3 inches) shall be either threaded, grooved, or welded; and piping 80 mm (3 inches) and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting according to MSS SP-25.

#### 2.5.2.1 Welded Joints and Fittings

Welded fittings shall conform to ASTM A 234/A 234M, and shall be identified with the appropriate grade and marking symbol. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11.

#### 2.5.2.2 Flanged Joints and Fittings

Flanges shall conform to ASTM A 181/A 181M and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material according to ASME B16.21, 2.0 mm thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

#### 2.5.2.3 Threaded Joints and Fittings

Threads shall conform to ASME B1.20.1. Unions shall conform to ASME B16.39, Class 150. Nipples shall conform to ASTM A 733. Malleable iron fittings shall conform to ASME B16.3, type as required to match piping.

#### 2.5.2.4 Dielectric Unions and Flanges

Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

2.5.2.5 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 862 kPa (125 psig) service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53/A 53M. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C or Grade No. M3BA610A15B44Z for circulating medium up to 93 degrees C. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.5.3 Copper Tube

Copper tube shall conform to ASTM B 88, and ASTM B 88M, Type K or L.

2.5.4 Joints and Fittings For Copper Tube

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75M. . Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.5.5 Valves

Valves shall be Class 125 and shall be suitable for the intended application. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 3 meters or higher above the floor. Valves in sizes larger than 25 mm (1 inch) and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

2.5.5.1 Gate Valves

Gate valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, solder, or flanged ends. Gate valves 80 mm (3 inches) and larger shall conform to MSS SP-70 and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.5.5.2 Globe Valves

Globe valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 80 mm (3 inches) and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.3 Check Valves

Check valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 80 mm (3 inches) and larger shall conform to MSS SP-71and shall be cast iron with bronze trim and flanged or threaded ends.

2.5.5.4 Angle Valves

Angle valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Angle valves 80 mm (3 inches) and larger shall conform to MSS SP-85and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.5 Ball Valves

Ball valves 15 mm (1/2 inch) and larger shall conform to MSS SP-72 or MSS SP-110, and shall be ductile iron or bronze with threaded, soldered, or flanged ends.

2.5.5.6 Butterfly Valves

Butterfly valves shall be 2 flange or lug wafer type, and shall be bubble-tight at 1.03 MPa. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 200 mm (8 inches) shall have throttling handles with a minimum of seven locking positions. Valves 200 mm (8 inches) and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.5.5.7 Balancing Valves

Balancing valves 50 mm (2 inches) or smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves 25 mm or larger may be all iron with threaded or flanged ends. The valves shall have a square head or similar device and an indicator arc and shall be designed for 120 degrees C. Iron valves shall be lubricated, nonlubricated, or tetrafluoroethylene resin-coated plug valves. In lieu of plug valves, ball valves may be used. Plug valves and ball valves 200 mm (8 inches) or larger shall be provided with manual gear operators with position indicators. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 862 kPa (125 psig) or 150 percent of the system operating pressure, whichever is the greater. Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, the system pump head capability shall be appropriately increased. Where flow readings are provided by remote or portable meters, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. A portable meter furnished with accessory kit as recommended by the automatic valve manufacturer shall be provided. Automatic flow control valve specified may be substituted for venturi tubes or orifice plate flow measuring devices.

2.5.5.8 Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for pressure rating of piping system and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for pressure rating of piping system.

2.5.6 Strainers

Strainer shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 0.8 mm (22 gauge) corrosion-resistant steel, with small perforations numbering not less than 60 per square centimeter (400 per square inch) to provide a net free area through the basket of at least 3.3 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.7 Chilled Water System Accessories

Chilled water system accessories such as pumps, combination strainer and suction diffusers, and expansion tanks shall be as specified in Section 15181 CHILLED & CONDENSER WATER PIPING & ACCESSORIES.

2.5.8 Water or Steam Heating System Accessories

Water or steam heating accessories such as expansion tanks and steam traps shall be as specified in Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

2.5.9 Backflow Preventers

Backflow preventers shall be according to Section 15400 PLUMBING, GENERAL PURPOSE.

2.5.10 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 862 kPa (125 psi) or 1034 kPa (150 psi) service as appropriate for the static head plus the system head, and 120 degrees C, 110 degrees C for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.5.11 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm in diameter and shall have a range from 0 kPa to approximately 1.5 times the maximum system working pressure.

2.5.12 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 225 mm (9 inch) scale, and shall have rigid stems with straight, angular, or inclined pattern.

2.5.13 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or setscrews.

2.5.14 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.5.15 Expansion Joints

2.5.15.1 Slip Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the traverse indicated. The joints shall be designed for working temperature and pressure suitable for the application, but not less than 1034 kPa (150 psig), and shall be according to applicable requirements of EJMA Stds and ASME B31.1. End connections shall be flanged or beveled for welding as indicated. Joint shall be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 0.058 mm of hard chrome according to ASTM B 650. All joint components shall be suitable for the intended service. Initial setting shall be made according to the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall be not more than 1.5 or smaller, guides shall be installed not more than 600 mm from the joint. Service outlets shall be provided where indicated.

#### 2.5.15.2 Flexible Ball Joints

Flexible ball joints shall conform to EJMA Stds and ASME B31.1 and be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. The joint ends shall be threaded to 50 mm (2 inches) only, grooved, flanged, or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15-degree angular flex and 360 degree rotation. Balls and sockets shall be suitable for the intended service. The exterior spherical surface of carbon steel balls shall be plated with mils of hard chrome according to ASTM B 650. The ball type joints shall be designed and constructed according to EJMA Stds and ASME B31.1 where applicable. Where required, flanges shall conform to ASME B16.5.

#### 2.5.15.3 Bellows Type Joints

Bellows type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows type expansion joints shall conform to the applicable requirements of EJMA Stds with internal sleeves. Guiding of piping on both sides of expansion joint shall be according to the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but not less than 1034 kPa (150 psig).

### 2.5.16 Insulation

Shop and field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 2.5.17 Condensate Drain Lines

Condensate drainage shall be provided for each item of equipment that generates condensate as specified for drain, waste, and vent piping systems in Section 15400 PLUMBING, GENERAL PURPOSE.

## 2.6 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 745 W and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 7.45 kW (10 hp) or less. Adjustable frequency drives shall be used for larger motors.

## 2.7 CONTROLS

Controls shall be provided as specified in Section 15952 DIRECT DIGITAL CONTROL SYSTEM FOR HVAC DYESS AFB.

## 2.8 DUCTWORK COMPONENTS

### 2.8.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 125, 250, and 500 Pa (1/2, 1, and 2 inch w.g.) ductwork shall meet the requirements of Seal Class C. Class 750 through 2500 Pa (3 through 10 inch) shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 50 mm band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

#### 2.8.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

#### 2.8.1.2 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runout length shall be as shown on the drawings, but shall in no case exceed 3 m. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

2.8.1.3 General Service Duct Connectors

A flexible duct connector approximately 150 mm in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.8.1.4 High Temperature Service Duct Connections

Material shall be approximately 2.38 mm thick, 1.2 to 1.36 kg per square meter (35 to 40-ounce per square yard) weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 650 degrees C.

2.8.2 Ductwork Accessories

2.8.2.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 375 x 450 mm, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 600 x 600 mm or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

2.8.2.2 Fire Dampers and Smoke Dampers

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555S. The Contractor shall perform the fire damper test as outlined in NFPA 90A.

A pressure relief damper shall be provided upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then this pressure relief damper shall be factory insulated. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir. Fire dampers shall be curtain type with damper blades out of the air stream or single blade type or multi-blade type. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.8.2.3 Splitters and Manual Balancing Dampers

Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 5 mm (3/16 inch) rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 200 mm (8 inches). Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 300 mm. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

2.8.2.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air deflectors, also called turning vanes, shall be provided in 90 degree elbows.

2.8.3 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.8.3.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 375 mm in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 375 mm in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 1.0 mm (20 gauge) galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53/A 53M, Schedule 20 shall be used. Sleeve shall provide 25 mm clearance between the duct and the sleeve or 25 mm clearance between the insulation and the sleeve for insulated ducts.

2.8.3.2 Framed Prepared Openings

Openings shall have 25 mm clearance between the duct and the opening or 25 mm clearance between the insulation and the opening for insulated ducts.

2.8.3.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 100 mm wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 375 mm in diameter or less shall be fabricated from 1.0 mm (20 gauge) galvanized steel. Collars for round ducts larger than 375 mm and square, and rectangular ducts shall be fabricated from 1.3 mm (18 gauge) galvanized steel. Collars shall be installed with fasteners on maximum 150 mm centers, except that not less than 4 fasteners shall be used.

2.8.4   Plenums and Casings for Field-Fabricated Units

2.8.4.1   Plenum and Casings

Plenums and casings shall be fabricated and erected as shown in SMACNA HVAC Duct Const Stds, as applicable. Unless otherwise indicated, system casing shall be constructed of not less than 1.6 mm (16 gauge) galvanized sheet steel. Cooling coil drain pans with 25 mm threaded outlet shall be provided to collect condensation from the cooling coils. Drain pans shall be fabricated of not lighter than 1.6 mm (16 gauge) steel, galvanized after fabrication or of 1.3 mm (18 gauge) corrosion-resisting sheet steel conforming to ASTM A 167, Type 304, welded and stiffened. Drain pans exposed to the atmosphere shall be thermally insulated to prevent condensation. Insulation shall be coated with a flame resistant waterproofing material. Separate drain pans shall be provided for each vertical coil section, and a separate drain line shall be provided for each pan. Pans shall be generously sized to ensure capture of entrained moisture on the downstream-air side of the coil. Openings in the casing, such as for piping connections, shall be sealed and covered to prevent air leakage. Water seal for the drain shall provide at least 500 Pa greater than the maximum negative pressure in the coil space.

2.8.4.2   Access Doors

Access doors shall be provided in each section of the casing. Door frames shall be welded in place, and each door shall be neoprene gasketed, hinged with minimum of two brass hinges, and fastened with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, doors shall be 900 x 450 mm located 450 mm above the floor. Where the space available will not accommodate doors of this size, doors as large as the space will accommodate shall be provided. Doors shall swing so that fan suction or pressure holds door in closed position, and shall be airtight. A push-button station to stop the supply fan shall be located inside the casing where indicated.

2.8.4.3   Duct Liner

Unless otherwise specified, duct liner shall conform to ASTM C 1071, Type I or II.

2.8.5   Sound Attenuation Equipment

a. Systems With Total Pressure Above 1 kPa (4 Inches Water Gauge) :

Sound attenuators shall be provided on the discharge duct of each fan operating at a total pressure above 1 kPa (4 inch water gauge), and, when indicated, at the intake of each fan system. Sound attenuators shall be provided elsewhere as indicated. The sound attenuators shall be factory fabricated and shall be tested by an independent laboratory for sound and performance characteristics. Net sound reduction shall be as indicated. Maximum permissible pressure drop shall not exceed 157 Pa (0.63 inch water gauge). Traps shall be constructed to be airtight when operating under an internal static pressure of 2.5 kPa. Air-side surface shall be capable of withstanding air velocity of 50 m/s (10,000 fpm). The Contractor shall certify that the sound reduction values specified will be obtained after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Sound absorbing material shall conform to ASTM C 1071, Type I or II. Sound absorbing material shall meet the fire hazard rating requirements for insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. A duct transition section shall be provided for connection to ductwork. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system may be provided in lieu of factory fabricated sound attenuators, and shall comply with requirements specified for factory fabricated sound attenuators. The double-walled duct and fittings shall be constructed of an outer metal pressure shell of zinc-coated steel sheet, 25 mm thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Sufficient length of run shall be provided to obtain the noise reduction coefficient specified. The Contractor shall certify that the sound reduction value specified will be obtained within the length of duct run provided. The outer sheet metal of the double-walled duct shall have welded, or spiral lock, seams to prevent water vapor penetration. The outer sheet of the duct and fittings shall conform to the metal thickness of high pressure spiral and round ducts and fittings shown in SMACNA HVAC Duct Const Stds. The acoustical insulation shall have a thermal conductivity "k" of not more than 0.0389 W/m-K (0.27 Btu/inch/square foot/hour/degree F) at 24 degrees C (75 degrees F) mean temperature. The internal perforated zinc-coated metal liner shall be not less than 0.7 mm (24 gauge) with perforations not larger than 6.35 mm (1/4 inch) in diameter providing a net open area not less than 10 percent of the surface.

a. System With Total Pressure of 1000 Pa (4 Inch Water Gauge) and Lower:

Sound attenuators shall be provided only where indicated, or in lieu of lined ducts. Factory fabricated sound attenuators shall be constructed of galvanized steel sheets. Outer casing shall be not less than 0.85 mm (22 gauge). Acoustical fill shall be fibrous glass. Net sound reduction shall be as indicated. Values shall be obtained on a test unit not less than 600 mm by 600 mm outside dimensions made by a certified nationally recognized independent acoustical laboratory. Air flow capacity shall be as indicated or required. Pressure drop through the attenuator shall not exceed the value indicated, or shall not be in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Sound attenuators shall be acoustically tested with metal duct inlet and outlet sections while under the rated air flow conditions. Noise reduction data shall include the effects of flanking paths and vibration transmission. Sound attenuators shall be constructed to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 500 Pa (2 inch water gauge).

a. Acoustical Duct Liner:

Acoustical duct lining shall be fibrous glass designed exclusively for lining ductwork and shall conform to the requirements of ASTM C 1071, Type I and II. Liner composition may be uniform density, graduated density, or dual density, as standard with the manufacturer. Lining shall be coated, not less than 25 mm thick. Where acoustical duct liner is used, liner or combination of liner and insulation applied to the exterior of the ductwork shall be the thermal equivalent of the insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Duct sizes shown shall be increased to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, acoustically equivalent lengths of fibrous glass duct or factory fabricated double-walled internally insulated duct with perforated liner may be provided. Net insertion loss value, static pressure drop, and air flow velocity capacity data shall be certified by a nationally recognized independent acoustical laboratory.

2.8.6 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 0.25 m/s (50 fpm) in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 2 m above the floor, they shall be protected by a grille or screen according to NFPA 90A.

2.8.6.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL Elec Const Dir for the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.8.6.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 150 mm below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 150 mm above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.8.7 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section {AM#0001} 07601 SHEET METALWORK, GENERAL {AM#0001}AIR FORCE.

2.8.8 Air Vents, Penthouses, and Goosenecks

Air vents, penthouses, and goosenecks shall be fabricated from galvanized steel sheets with galvanized structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA HVAC Duct Const Stds. Louver blades shall be accurately fitted and secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Air vents, penthouses, and goosenecks shall be provided with bird screen.

2.8.9 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, No. 2 mesh, aluminum or stainless steel. Aluminum screens shall be rated "medium-light". Stainless steel screens shall be rated "light". Frames shall be removable type, or stainless steel or extruded aluminum.

2.9 AIR SYSTEMS EQUIPMENT

2.9.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 11 kW (15 hp) and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to 750 mm (30 inches). Fan blades for wheels over 750 mm (30 inches) in diameter shall be backward-inclined or airfoil design. Fan wheels over 900 mm (36 inches) in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 900 mm (36 inches) or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. operated outlet dampers shall be provided. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have totally enclosed enclosures. Motor starters shall be magnetic across-the-line type with general-purpose enclosure.

2.9.1.2 In-Line Centrifugal Fans

In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Fans shall be mounted in a welded tubular casing. Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Motors shall have totally enclosed enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosures.

2.9.1.3 Axial Flow Fans

Axial flow fans shall be complete with drive components and belt guard, and shall have a steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Fan wheels shall have radially projecting blades of airfoil cross section and shall be dynamically balanced and keyed to the fan shaft. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt, shall be permanently lubricated or with accessible grease fittings, and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours of operation as defined by AFBMA Std 9 and AFBMA Std 11. Fan inlets shall be provided with an aerodynamically shaped bell and an inlet cone. Diffuser or straightening vanes shall be provided at the fan discharge to minimize turbulence and provide smooth discharge air flow. Unless otherwise indicated, motors shall not exceed 1800 rpm and shall have totally enclosed enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosure.

2.9.1.4 Ceiling Exhaust Fans

Suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Fan motors shall be mounted on vibration isolators. Unit shall be provided with mounting flange for hanging unit from above. Fans shall be U.L. listed.

2.9.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.406 mm (0.016 inches). Aluminum fins shall be 0.14 mm (0.0055 inch) minimum thickness. Copper fins shall be 0.114 mm (0.0045 inch) minimum thickness. Casing and tube support sheets shall be not lighter than 1.6 mm (16 gauge) galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 2.76 MPa (400 psi) air pressure and shall be suitable for 1.38 MPa (200 psi) working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

2.9.2.1 Water Coils

Water coils shall be installed with a pitch of not less than 10 mm per meter of the tube length toward the drain end. Headers shall be constructed of cast iron, welded steel or copper. Each coil shall be provided with a plugged vent and drain connection extending through the unit casing.

2.9.3 Air Filters

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

2.9.3.1 Replaceable Media Filters

Replaceable media filters shall be the dry-media type, of the size required to suit the application. Filtering media shall be not less than 50 mm (2 inches) thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 1.6 mm (16 gauge) galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not exceeding 1.5 m/s , with initial resistance of 32 Pa . Average efficiency shall be not less than 30 percent when tested according to ASHRAE 52.1.

2.9.3.2 Holding Frames

Frames shall be fabricated from not lighter than 1.6 mm (16 gauge) sheet steel with rust-inhibitor coating. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.

2.9.3.3 Filter Gauges

Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 98 mm (3-7/8 inches) in diameter, shall have white dials with black figures, and shall be graduated in 0.0025 kPa mm (0.01 inch of water), and shall have a minimum range of 0.25 kPa (1 inch of water) beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two static pressure tips with integral compression fittings, two molded plastic vent valves, two 1.5 m (5 foot) minimum lengths of 6.35 mm (1/4 inch) diameter aluminum tubing, and all hardware and accessories for gauge mounting.

2.10 AIR HANDLING UNITS

2.10.1 Factory-Fabricated Air Handling Units

Units shall be as indicated. Units shall include fans, coils, airtight insulated casing, adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, vibration-isolators, and appurtenances required for specified operation. Vibration isolators shall be as indicated. Each air handling unit shall have physical dimensions suitable to fit space allotted to the unit and shall have the capacity indicated. Air handling unit shall have published ratings based on tests performed according to ARI 430.

2.10.1.1 Casings

Casing sections shall be 2 inch double wall type as indicated, constructed of a minimum 18 gauge galvanized steel, or 18 gauge steel outer casing protected with a corrosion resistant paint finish according to paragraph FACTORY PAINTING. Inner casing of double-wall units shall be minimum 1.0 mm (20 gauge) solid perforated galvanized steel. Casing shall be designed and constructed with an integral structural steel frame such that exterior panels are non-load bearing. Exterior panels shall be individually removable. Removal shall not affect the structural integrity of the unit. Casings shall be provided with inspection doors, access sections, and access doors as indicated. Inspection and access doors shall be insulated, fully gasketed, double-wall type, of a minimum 1.3 mm (18 gauge) outer and

1.0 mm (20 gauge) inner panels. Doors shall be rigid and provided with heavy duty hinges and latches. Inspection doors shall be a minimum 300 mm wide by 300 mm high. Access doors shall be minimum 600 mm wide and shall be the full height of the unit casing or a minimum of 1800 mm, whichever is less. Access Sections shall be according to paragraph AIR HANDLING UNITS. Drain pan shall be double-bottom type constructed of 16 gauge stainless steel, pitched to the drain connection. Drain pans shall be constructed water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils shall not flow across the face of lower coils. Intermediate drain pans or condensate collection channels and downspouts shall be provided, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Each casing section handling conditioned air shall be insulated with not less than 25 mm (1 inch) thick, 24 kg per cubic meter (1-1/2 pound density) coated fibrous glass material having a thermal conductivity not greater than 0.033 W/m-K (0.23 Btu/hr-sf-F). Factory applied fibrous glass insulation shall conform to ASTM C 1071, except that the minimum thickness and density requirements do not apply, and shall meet the requirements of NFPA 90A. Foam-type insulation is not acceptable. Foil-faced insulation shall not be an acceptable substitute for use on double-wall access doors and inspections doors and casing sections. Duct liner material, coating, and adhesive shall conform to fire-hazard requirements specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Exposed insulation edges and joints where insulation panels are butted together shall be protected with a metal nosing strip or shall be coated to conform to meet erosion resistance requirements of ASTM C 1071. A latched and hinged inspection door, shall be provided in the fan and coil sections. Additional inspection doors, access doors and access sections shall be provided where indicated.

2.10.1.2 Heating and Cooling Coils

Coils shall be provided as specified in paragraph AIR SYSTEMS EQUIPMENT, for types indicated.

2.10.1.3 Air Filters

Air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.10.1.4 Fans

Fans shall be double-inlet, centrifugal type with each fan in a separate scroll. Fans and shafts shall be dynamically balanced prior to installation into air handling unit, then the entire fan assembly shall be statically and dynamically balanced at the factory after it has been installed in the air handling unit. Fans shall be mounted on steel shafts accurately ground and finished. Fan bearings shall be sealed against dust and dirt and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Bearings shall be permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Bearings shall be supported by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Bearings may not be fastened directly to the unit sheet metal casing. Fans and scrolls shall be furnished with coating indicated. Fans shall be driven by a unit-mounted or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Belt guards shall be the three sided enclosed type with solid or expanded metal face. Belt drives shall be designed for not less than a 1.3 service factor based on motor nameplate rating. Motor sheaves shall be variable pitch for 20 kW and below and fixed pitch above 20 kW as defined by ARI Guideline D. Where fixed sheaves are required, variable pitch sheaves may be used during air balance, but shall be replaced with an appropriate fixed sheave after air balance is completed. Variable pitch sheaves shall be selected to drive the fan at a speed that will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable bases. Fan motors shall have open enclosures. Motor starters shall be magnetic type with general-purpose enclosure. Unit fan or fans shall be selected to produce the required capacity at the fan static pressure. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300 or ASHRAE 68.

2.10.1.5 Access Sections and Filter/Mixing Boxes

Access sections shall be provided where indicated and shall be furnished with access doors as shown. Access sections and filter/mixing boxes shall be constructed in a manner identical to the remainder of the unit casing and shall be equipped with access doors. Mixing boxes shall be designed to minimize air stratification and to promote thorough mixing of the air streams.

2.10.1.6 Dampers

Dampers shall be as specified in paragraph CONTROLS.

2.11 TERMINAL UNITS

2.11.1 Variable Air Volume (VAV) {AM#0001}__________Units

VAV and dual duct terminal units shall be the type, size, and capacity shown and shall be mounted in the ceiling or wall cavity and shall be suitable for single or dual duct system applications. Actuators and controls shall be as specified in paragraph CONTROLS. Unit enclosures shall be constructed of galvanized steel not lighter than 0.85 mm (22 gauge or aluminum sheet not lighter than 1.3 mm (18 gauge). Single or multiple discharge outlets shall be provided as required. Units with flow limiters are not acceptable. Unit air volume shall be factory preset and readily field adjustable without special tools. Reheat coils shall be provided as indicated. A flow chart shall be attached to each unit. Acoustic performance of the terminal units shall be based upon units tested according to ARI 880. Sound power level shall be as indicated. Discharge sound power shall be shown for minimum and 375 Pa (1-1/2, and inches water gauge) inlet static pressure. Acoustical lining shall be according to NFPA 90A.

#### 2.11.1.1 Variable Volume, Single Duct

Variable volume, single duct, terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Units shall control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 200 to 1500 Pa (3/4 to 6 inch water gauge). Internal resistance of units shall not exceed 100 Pa (0.4 inch water gauge) at maximum flow range. External differential pressure taps separate from the control pressure taps shall be provided for air flow measurement with a 0 to 250 Pa (0 to 1 inch water gauge) range. Unit volume controller shall be normally closed upon loss of control power.

#### 2.11.1.2 Variable Volume, Single Duct, Fan-Powered

Variable volume, single duct, fan-powered terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Units shall control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 200 to 1500 Pa (3/4 to 6 inch water gauge). Unit fan shall be centrifugal, direct-driven, double-inlet type with forward curved blades. Fan motor shall be either single speed with speed controller or three-speed, permanently lubricated, permanent split-capacitor type. Fan/motor assembly shall be isolated from the casing to minimize vibration transmission. Fan control shall be factory furnished and wired into the unit control system. A factory-mounted pressure switch shall be furnished to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

#### 2.11.1.3 Reheat Units

a. Hot Water Coils: Hot-water coils shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube support sheets shall be 1.6 mm (16 gauge), galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. At the factory, each coil shall be tested at not less than 1700 kPa (250 psi) air pressure and shall be suitable for 1400 kPa (200 psi) working pressure. Drainable coils shall be installed in the air handling units with a pitch of not less than 10 mm per m (1/8 inch per foot ) of tube length toward the drain end. Coils shall conform to the provisions of ARI 410.

### 2.12 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 3 mm. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

### 3.1.1 Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall be not less than 2 mm in 1 m. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 65 mm (2-1/2 inches) or less in diameter, and with flanges for pipe 80 mm (3 inches) and larger. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

#### 3.1.1.1 Joints

a. Threaded Joints: Threaded joints shall be made with tapered threads and made tight with a stiff mixture of graphite and oil or polytetrafluoroethylene tape or equivalent thread joint compound or material, applied to the male threads only.

b. Soldered Joints: Joints in copper tubing shall be cut square with ends reamed, and all filings and dust wiped from interior of pipe.

Joints shall be soldered with 95/5 solder or brazed with silver solder applied and drawn through the full fitting length. Care shall be taken to prevent annealing of tube or fittings when making connections. Joints 65 mm (2-1/2 inches) and larger shall be made with heat uniformly around the entire circumference of the joint with a multi-flame torch. Connections in floor slabs shall be brazed. Excess solder shall be wiped from joint before solder hardens. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

c. Welded Joints: Welding shall be according to qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified according to ASME BPV IX. Welding procedures qualified by others and welders and welding operators qualified by another operator may be permitted by ASME B31.1. Structural members shall be welded according to Section 05055 WELDING, STRUCTURAL. All welds shall be permanently identified by imprinting the welder's or welding operator's assigned symbol adjacent to the weld. Welded joints shall be fusion welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. Electrodes shall be stored and dried according to AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.1.2 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.1.1.3 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.1.2 Supports

3.1.2.1 General

Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.2.2 Seismic Requirements (Pipe Supports and Structural Bracing)

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Section 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05210 STEEL JOISTS.

3.1.2.3 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Types 5, 12, and 26 shall not be used.

a. Hangers: Type 3 shall not be used on insulated piping.

b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.

f. Type 39 saddles shall be used on all insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is above 15.5 degrees C. Type 39 saddles shall be welded to the pipe.

g. Type 40 shields shall:

(1) be used on all insulated pipes less than 100 mm (4 inches).

(2) be used on all insulated pipes 100 mm (4 inches) and larger when the temperature of the medium is 15.5 degrees C or less.

(3) have a high density insert for pipe 50 mm (2 inches) and larger, and for smaller pipe when the insulation shows signs of being visibly compressed, or when the insulation or jacket shows visible signs of distortion at or near the type 40 shield. High density inserts shall have a density of 144 kg/cubic meter (9 pcf) or greater.

h. Horizontal Pipe Supports: Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm (1 foot) from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 220 N (50 pounds) shall have the excess hanger loads suspended from panel points.

i. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 5 m , not more than 2.4 m from end of risers, and at vent terminations.

j. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

k. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger with medium 15.5 degrees C or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm (4 inches), a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

l. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm, or by an amount adequate for the insulation, whichever is greater.

m. Insulated Pipe: Insulation on horizontal pipe shall be continuous through hangers for hot and cold piping. Other requirements on insulated pipe are specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 3.1.3 Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.1.4 Pipe Sleeves

Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall provide a minimum of 6 mm all-around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve, in non-fire rated walls, shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed as indicated.

3.1.4.1 Roof and Floor Sleeves

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17-ounce copper sleeve or a 0.8 mm thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 200 mm from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. Unless otherwise shown, the flashing sleeve shall extend up the pipe a minimum of 50 mm above highest floor level or a minimum of 250 mm above the roof. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 250 mm (10 inches) in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.1.4.2 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.1.4.3 Escutcheons

Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be secured to pipe or pipe covering.

3.1.5 Condensate Drain Lines

Water seals shall be provided in the condensate drain from all units. The depth of each seal shall be 50 mm plus 0.1 mm for each Pa, of the total static pressure rating of the unit to which the drain is connected. Water seals shall be constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Pipe cap or plug cleanouts shall be provided where indicated. Drains indicated to connect to the sanitary waste system shall be connected by an indirect waste fitting. Air conditioner drain lines shall be insulated as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.6 Pipe-Alignment Guides

Pipe-alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m on each side of each expansion joint, and in lines 100 mm (4 inches) or smaller not more than 600 mm on each side of the joint.

3.1.7 Air Vents and Drains

3.1.7.1 Vents

Air vents shall be provided at high points, on water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7.2 Drains

Drains shall be provided at low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment such as pumps, heaters, heating or cooling coils, and other similar items, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purposes. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

#### 3.1.9 Equipment and Installation

Frames and supports shall be provided for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Air handling units shall be floor mounted or ceiling hung, as indicated. The method of anchoring and fastening shall be as detailed. Floor-mounted equipment, unless otherwise indicated, shall be set on not less than 150 mm (6 inch) concrete pads or curbs doweled in place. Concrete foundations for circulating pumps shall be heavy enough to minimize the intensity of the vibrations transmitted to the piping and the surrounding structure, as recommended in writing by the pump manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. The concrete foundation or concrete pedestal block shall be of a mass not less than three times the weight of the components to be supported. Lines connected to the pump mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.10 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

#### 3.1.11 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

#### 3.1.12 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

#### 3.1.13 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

### 3.1.14 Acoustical Duct Lining

Lining shall be applied in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84. Top and bottom pieces shall lap the side pieces and shall be secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA HVAC Duct Const Stds. Welded pins, cup-head pins, or adhered clips shall not distort the duct, burn through, nor mar the finish or the surface of the duct. Pins and washers shall be flush with the surfaces of the duct liner and all breaks and punctures of the duct liner coating shall be sealed with the nonflammable, fire resistant adhesive. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Duct liner may be applied to flat sheet metal prior to forming duct through the sheet metal brake. Lining at the top and bottom surfaces of the duct shall be additionally secured by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA HVAC Duct Const Stds to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, will be acceptable.

### 3.1.15 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

### 3.1.16 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated up to the point where the outdoor air reaches the conditioning unit.

### 3.1.17 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

### 3.1.18 Power Roof Ventilator Mounting

Foamed 13 mm (1/2 inch) thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

### 3.1.19 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

## 3.2 FIELD PAINTING AND COLOR CODE MARKING

Finish painting of items only primed at the factory, surfaces not specifically noted otherwise, and color code marking for piping shall be as specified in Section 09900 PAINTING, GENERAL.

## 3.3 PIPING HYDROSTATIC TEST

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure will be allowed. Leaks shall be repaired by re-welding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before covering or concealing.

## 3.4 DUCTWORK LEAK TEST

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans, coils, filters, etc. designated as static pressure Class 750 Pa (3 inch water gauge) through Class 2500 Pa (10 inch water gauge). Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. The maximum allowable leakage rate is 10 l/s (5 cfm). Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

## 3.5 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Inside of air terminal units, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

## 3.6 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

## 3.7 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 2 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

## 3.8 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 8 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

SECTION 15952

DIRECT DIGITAL CONTROL SYSTEM FOR DYESS AFB
**09/2000**
**AMENDMENT NO. 0001**

PART 1 GENERAL

1.1 OVERVIEW

Provide all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein.

1.1.1 Scope

The DDCS drawings indicate the major DDC system components and the method of communication to be used between the system components. All new hardware and software shall be provided and shall be compatible with the existing facilities management control system (FMCS {AM#0001}Siebe Controls ) at Dyess AFB.

The DDC System input/output summary indicates the minimum number of analog and digital input and output points, the minimum hardware I/O devices, and the minimum software programs to be provided. Any additional hardware I/O devices or software programs necessary to meet the requirements herein or in the sequence of controls (attached hereinafter)) shall also be provided.

The drawings indicate the layout and general arrangement of the major existing and new heating, air conditioning and ventilation system components all HVAC system components to include air supply fans, variable speed drives, exhaust fans, chilled water coils, hot water coils, air terminal units, steam supply, hot water supply, hot water pumps and smoke detection devices shall be monitored and or controlled whether or not indicated. The existing equipment capabilities indicated shall be used to calculate and rebalance the air and water supply on existing equipment.

{AM#0001}DELETED

All existing EMCS Equipment as manufactured by Williams Electric Company and Associated Components shall be removed from service and turned over to the Government to include but not limited to field interface device cabinets, multiplexer cabinets, control stations, sensors, relays, enclosures, power supplies, communication surge protectors, wiring and conduit.

Provide all circuit breaker panels, breakers, safety switches, junction boxes, starters, control switches, conduit power and control wiring as required for a complete usable system. All wiring shall be run in conduit and concealed except where inside the mechanical rooms. Low voltage, plenum rated low energy fire resistant and low smoke producing sensor wiring not otherwise required by code to be inside conduit may be used in concealed attic and wall spaces.

The Government will not provide any additional control or power wiring information. Contractor shall provide all field survey work to trace our control, power and communication circuits, and verify nameplate data on existing equipment.

Contractor shall coordinate the requirements for telephone and local area network communications with the local telephone company, the Base Communications Squadron, The 7CES Energy Manager, and the using organization.

Reprogram the existing DYESS AFB FMCS Graphical Interface Software for the three existing central host stations to include all of the new Bldg. 9201DDCS controlled and monitored components.

Equipment and control systems installed under this contract, which include hardware, software, firmware and middleware or a combination thereof, shall be Year 2000 compliant as defined in FAR Part 39. An extended warranty period (for Year 2000 compliance only) shall be provided to the end of year 2001 or 2002 to insure that all such equipment and and control systems work. Failure of equipment or control systems as a result of being non-Year 2000 compliant shall be repaired or replaced at no additional cost to the Government.

## 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE No. 142 | (1982) Recommended Practice for Grounding of Industrial and Commercial Power Systems |
| IEEE C62.41 | (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (1997) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | (1993) Industrial Control and Systems |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | (1999) Installation of Air Conditioning and Ventilating Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 864 | (1996; Rev thru Aug 1999) Control Units for Fire-Protective Signaling Systems |

## 1.3 GENERAL REQUIREMENTS

### 1.3.1 Abbreviations, Symbols, and Definitions

All letter symbols and engineering unit abbreviations utilized in information displays and printouts shall conform to the ASHRAE "Handbook of Fundamentals".

### 1.3.2 Nomenclature

Provide Model Numbers indicated below as manufactured by Seibe Environmental Controls, Network 8000):

| | |
|---|---|
| FMCS | Facility Management Control System Graphical - Software<br><br>DataTalk Development Corporation, Signal Version 4.x Software |
| SDC | Standalone Digital Controller - Local Control Module LCM-84X10 with built-in alpha-numeric keyboard and display or LCM-84X10 with front swing-out panel mounted ProView RROV-GCM programmers keyboard and display |
| ADC | Ancillary Digital Controller - Microzone II, MZ2-1x |
| GDC | Gateway Digital Controller - Global Control Module, GCM-86xx with Echelon Network Interface Module GCM-ECH-001 |
| UDC | Unitary Digital Controller - Micronet 2000, MN-HPFC |
| HHOT | Hand Held Operator Terminal - Existing |
| CHS | Central Host Stations - Existing |
| GP | Graphical Programmer - Existing |
| CHS | Central Host Station - Existing |
| TI | Telephone Interface - Existing |

### 1.3.3 Identical Items

Equipment, assemblies, parts, and components of the same classification as specified in PART 2 PRODUCTS shall be the same manufacturer and model number.

### 1.3.4 Nameplates, Lens Caps, and Tags

Nameplates and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. Nameplates shall be mechanically attached to Direct Digital Control (DDC) panel interior doors. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Identifiers shall match the device identifiers on the documentation and in the software.

### 1.3.5 Control Wire Labeling:

Provide control wire near end and far end labeling at each end of each control wire. The near end label shall be attached nearest to the cable end; the far end label shall be attached immediately adjacent to the near end label; both shall be within 12 inches of the cable end and within easy view. The near end label shall indicate the cable number, terminal block number, and terminal number, such that any cable may be readily identified and reconnected to its proper terminal without reference to any cable diagram. The far end label shall indicate the cabinet number, equipment or instrument tag number, terminal block number, and terminal number for the opposite end of the cable. Use heat shrink type labels marked in permanent, non-fading ink, and covered with a transparent protective tape layer or covering. Cable identifiers shall match the identifiers on the documentation.

### 1.3.6 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

### 1.3.7 Drawings

All offsets, fittings, and accessories may not be indicated on the drawings. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

### 1.3.8 Factory Quality Certification

The contractor shall provide documentation that the DDC system manufacturer complies with ISO-9001 for Quality Assurance in Design/Development, Production, Installation, and Servicing.

### 1.3.9 Power-Line Surge Protection

All equipment connected to ac circuits shall be protected from power line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

### 1.3.10 Surge Protection for Signal and Communication Wiring

All DDC equipment shall have their signal and communication circuits protected against overvoltage conditions in accordance with UL 864, sub-category UUKL.

1.3.11 System Overall Reliability Requirement

Each DDC panel shall be designed, configured, installed and programmed to provide for stand alone operation with no performance degradation on failure of other system components to which it is connected or with which it communicates.

1.3.12 Multiple DDC Panel Requirement

Where controlled equipment is located in multiple mechanical rooms, each mechanical room shall have at least one DDC panel. DDC panels shall not control equipment located in a different mechanical room. DDC panels shall be located in the same room as the equipment being controlled or in an adjacent space which has direct access to the equipment room.

1.3.13 System Accuracy and Display

The system shall maintain an end-to-end accuracy for 1 year from sensor to operator's console display for the applications specified and shall display the value as specified. All temperatures shall be displayed and printed to the nearest .1 degree F.

1.3.13.1 Space Temperature

End-to-end accuracy of space temperature sensing with a range of 50 to 85 degrees F, shall be plus or minus 0.75 degree F. End-to-end accuracy for all other space temperature sensing shall be plus or minus 1.0 degree F.

1.3.13.2 Duct Temperature

End-to-end accuracy of duct temperature sensing with a range of 40 to 140 degrees F, shall be plus or minus 2.0 degrees F.

1.3.13.3 Outside Air Temperature

End-to-end accuracy of outside air temperature sensing with a range of minus 30 to 130 degrees F, shall be plus or minus 2.0 degree F.

1.3.13.4 Water Temperature

End-to-end accuracy of water temperature sensing shall be plus or minus 0.75 degrees F for a sensing range of 30 to 100 degrees F, plus or minus 2.0 degrees F for a sensing range of 100 to 250 degrees F; and plus or minus 0.5 degrees F for all sensors used for the purpose of performing Btu calculations using differential temperatures.

1.3.13.5 High Temperature

End-to-end accuracy of high temperature sensing applications with a range of 200 to 500 degrees F, shall be plus or minus 2.0 degree F.

1.3.13.6 Relative Humidity

Relative humidity measurement shall have an end to end accuracy of plus or minus 3.0 percent within the range of 20 to 80 percent relative humidity.

1.3.13.7 Pressure

End-to-end accuracy for pressure measurements shall be plus or minus 2.0 percent of the range to be measured.

1.3.13.8 Analog Value Input

An analog value input to the system's equipment via an AI shall be accurate to within 0.1 percent of range, not including the sensor or transmitter error. This accuracy is required over the specified environmental conditions.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

HVAC Control System; G, ED.

Submit the following drawings. Provide 2 copies on MS DOS diskettes in uncompressed AutoCAD importable format. Show all information in this section on the drawings. Obtain the signature of the reviewing authority prior to commencement of contractor provided training.

a. Drawing index and legend

b. Control system schematic

c. Ladder diagrams

d. Sequence of operation

e. Component wiring diagrams

f. Terminal strip diagrams

g. CRT graphic screens floor plan and schematic layouts

h. CRT alarm, data log, and menu screen layouts

(1) Control System Schematic

Provide control system schematic that includes the following:

a. Location of each input and output device

b. Flow diagram of each HVAC component, for instance flow through coils, fans, dampers

c. Name or symbol for each component such as V-1, DM-2, T-1 for valve, damper motor, and temperature sensor, respectively

d. Set points

e. Sensor range

f. Actuator range

g. Valve and damper schedules and normal position

h. Switch points on input switches

i. Written sequence of operation for each schematic

j. Graphic sequence of operation for each schematic

k. Schedule identifying each sensor and controlled device with the following information:

(1) Software point name
(2) Point type (AO, AI, DO, DI)
(3) Point range (4 to 20 ma, 3 to 15 psi, 10,000 ohm thermistor or 1000 Ohm Balco)
(4) Digital controller number to which the point connects.

(2) Ladder diagrams

Submit diagrams showing electrical equipment interlocks, including voltages and currents.

(3) Sequence of operation

Narrative sequence of operation for each system, referring to each device by its unique identifier.

(4) Component Wiring Diagrams

Submit a wiring diagram for each type of input device and each type of output device. Diagram shall show how the device is wired and powered; showing typical connections at the digital controller and each power supply, as well as at the device itself. Show for all field connected devices, including, but not limited to, control relays, motor starters, electric or electronic actuators, and temperature, pressure, flow, proof, and humidity sensors and transmitters.

(5) Terminal Strip Diagrams

Submit a diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.

Schedules; G, ED.

a. List of shop drawings

b. List of symbols and abbreviations used on shop drawings

c. List of I/O points

d. Equipment components list

e. AC power table

(1) List of shop drawings

Provide a list of shop drawings.

(2) List of symbols and abbreviations used on shop drawings

Provide an index of symbols and abbreviations used on the shop drawings.

(3) List of I/O points

For each input and output physically connected to a digital controller provide, on a controller by controller basis, provide the following:

a. Point description: for example: mixed air temperature, supply start/stop, etc.

b. Point type: AO, AI, DO, or DI.

c. Point range: 4-20 ma, 3-15 psi, thermistor.

d. Sensor range associated with point range: for example 0-100 deg F, 0-2 inches of water.

e. Software name(s) associated with point, if any.

f. Terminal number to which point is connected.

(4) Equipment Components List

Submit a listing of controllers and connected devices shown on control system schematic. List the following:

a. Control system schematic component name

b. Description

c. Manufacturer of controller

d. Controller's name

e. Equipment part numbers

f. Cv for valves

(5) AC power table

Submit a table listing each controller and the circuit breaker number, panel box number, and physical location of each controller's source of AC power.

Statements.

Prior to award, submit the following statements for approval to the reviewing authority.

a. Contractors' Qualifications:

Submit statements required in Part 1, Quality Assurance, Qualifications.

b. Training:

Submit schedule, syllabus, and training materials in accordance with Part 3, EXECUTION.

SD-03 Product Data

HVAC Control system; G, ED.

a. DDC hardware

b. DDC capabilities

c. Input devices

d. Output devices

e. Surge and transient protection

f. Smoke detectors

g. Panel mounted display and keypad

Submit manufacturers' specification sheets for each type of equipment to show compliance with the project specification. For each type of equipment highlight each compliance item and reference each item to the relevant specification paragraph number. Submit sufficient manufacturers' information to allow verification of compliance by the reviewing authority. Equipment and software for which specification compliance data shall be submitted include but not limited to the following:

(1) DDC Hardware

a. I/O; capable of supporting platinum RTD, precision thermistor, 4-20 mA

b. Programs will reside in microprocessor; controllers are stand-alone

c. Communications ports; all communications ports as specified

d. Protected memory; minimum hours required by this specification

e. Operating temperature limits

(2) DDC Capabilities

a. Communications; baud rates, communication ports, stand-alone

b. Trending; capable of trending every point

c. Alarming; capable of alarm generation as indicated

d. Messages; as indicated

e. Self diagnostics; identification of a failed module

f. PID control; capable of PID control

(3) Input Devices

a. Transmitters; accuracy, 4-20 mA

b. Temperature sensors; 10,000 Ohm Thermistor or 1000 Ohm Balco

c. Humidity sensors; type of sensor, accuracy, range, and stability

d. Pressure sensors; accuracy

e. Flow or motor proof; type

f. Sensor wells; type

(4) Output Devices

a. Dampers; types

b. Valves; types

c. Actuators

d. Control relays

(5) Surge and Transient Protection

a. Power line

b. Communications lines

c. Sensor and control wiring

SD-06 Test Reports

Field Test Reports; G, RE.

Submit the following for approval in accordance with paragraph entitled "Field Quality Control:"

a. Field tests

b. Performance verification tests

c. Opposite season test

(1) Test Procedures:

a. Phase 1: Field tests

(1) System inspection
(2) Input calibration accuracy and operation test
(3) Operation of outputs test
(4) Actuator range adjustment test
(5) Digital controller start-up and memory test
(6) Surge protection test
(7) Application software operation test

b. Phase 2: Performance verification tests

(1) Execution of sequence of operation
(2) Control loop stability and accuracy
(3) End to end system accuracy

c. Phase 3: Opposite season test

Field Test Documentation

Submit a report for each phase of field performance verification testing showing results of the testing in accordance with Part 3 EXECUTION. Documentation shall consist of expected/actual response of sensors, actuators, and controllers. Submit trend graphs to prove control loop stability and accuracy, proper execution of temperature control programs (sequence of operation), and proper operation of equipment interlocks.

SD-07 Certificates

Certificate of Compliance; G, RE.

Provide certificates of compliance stating the following equipment meet all hardware and software requirements:

a. Digital controllers

b. Smoke detectors

c. Test equipment accuracy

SD-10 Operation and Maintenance Data

HVAC Control System;G, RE.

Submit 3 copies of the Operations and Maintenance Manual 30 days prior to any system testing. Manuals shall be bound in hardback, looseleaf binders and each binder's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. Submit 6 final copies of the manual after completion of the endurance test. Final copies shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall include the following information:

a. Functional Design Manual

b. DDC Hardware Manufacturers' Manuals

c. Sensor and Control Components Manual

d. Operator's Manual

<u>a. Functional Design Manual:</u>

The Functional Design Manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. The Manual shall include the following as a minimum:

a. Definitions:

Definitions should be lifted from the specification definitions section.

b. DDC system description:

In a narrative form describe the size, architecture, and functionality of the direct digital control system.

c. Sequence of operation:

Provide sequence in narrative text and graphic chart formats.

d. Drawings:

Provide as-built drawing set from SD-04.

e. Field Acceptance Tests:

Provide approved procedures and results of tests.

b. DDC Hardware Manufacturers' Manuals

Provide the following manuals.

a. Specifications of components

b. Installation instructions

c. Operation instructions

d. Service instructions

e. Software documentation

f. Repair methods

g. Recommended tools

h. Recommended spare parts

i. List of qualified service organizations

c. Sensor and Control Components Manual

Submit detailed information of control system components external to the field installed digital controllers. Submit manufacturers' manuals detailing specifications, installation, maintenance, and calibration.

a. Installation instructions and checkout procedures.

b. Alignment and calibration procedures.

c. Manufacturer's repair parts list indicating sources of supply.

d. Operator's Manual

The Operator's Manual shall contain the all information necessary to operate and troubleshoot the direct digital control system. It shall include but not limited to the following:

a. Initializing Digital Controllers: Include documentation for set-up, from scratch, of the digital controllers. Include shop drawings showing cable connections, dip switch settings, and each equipment setting essential for proper operation of each digital controller. Include information necessary to initialize the digital controllers to a point they can accept control programs from a computer.

b. Uploading and Downloading Controller Software: Include step by step procedures for uploading and downloading control programs to/from digital controllers and workstation computer or by directly connected computer.

c. Point Set-up Documentation: Include complete documentation for the software setup, on a controller by controller basis, of every physical and virtual point. This includes point name, point type, point description, point location (if a physical I/O point), span, offset, slope, intercept, change of value, and any other characteristic used to define the point.

d. Scheduling and Set Point Adjustment: Include step-by-step procedures for making set point and equipment scheduling changes through workstation software or by direct connection to a digital controller.

e. Controller Diagnostics: Include documentation describing running and analyzing controller diagnostics. Define LED indicators.

f. Alarms and Messages: List alarms and messages programmed into the digital controllers. Describe probable causes of all alarms.

g. Applications software: Include complete documentation for programming control sequences.

h. PID Loop Tuning: Include PID loop tuning procedures for the control system.

SD-11 Closeout Submittals

Posted Control Diagrams and Instructions;G, RE.

Provide laminated permanent, non-fading, drawings under laminated plastic, showing complete instrumentation and control diagrams for all controls provided and interfaces to all existing equipment. The posted diagrams shall include the control sequence, control schematic, programming diagrams, wiring diagram in ladder format, valve schedules, and damper schedules. Provide one copy of condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the systems manually shall be prepared in typed form located in the primary mechanical room of each facility. Proposed diagrams, instructions and other sheets shall pertain only to the systems for the facility in which they are located and shall be submitted for Contracting Officer for approval prior to posting and prior to acceptance testing of the systems.

Administrative and Closeout Submittals;G, RE.

Provide administrative and closeout submittals as specified:

a. Training course documentation

b. Service organization

c. Contractor certification

a. Training Course Documentation

Training course documentation for each selected module shall include a manual for each trainee plus two additional copies and two copies of audiovisual training aids, if used. Documentation shall include an agenda, defined objectives for each lesson and detailed description of the subject matter of each lesson.

b. Service Organization

Qualified service organization list that shall include the names and telephone numbers of organizations qualified to service the HVAC control systems.

c. Contractor Certification

Provide certification that the installation of the control system is complete and the technical requirements of this section have been met.

## 1.5 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

## 1.6 TESTING

### 1.6.1 Site Testing

Provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing, adjusting, calibration and commissioning. The tests shall not be conducted during scheduled seasonal off-periods of base heating and cooling systems. Wiring shall be tested for continuity and for ground, open, and short circuits. Ground rods installed by the Contractor shall be tested as specified in IEEE No. 142. Obtain written Government approval of the specific site-testing procedures prior to any test.

Written notification of any planned site-testing, commissioning or tuning shall be given to the Government at least 14 calendar days prior to any test.

### 1.6.2 Control System Calibration, Adjustments, and Commissioning

All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. Adjust all control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, before the system is placed on-line. Communications requirements shall be as indicated in these specifications. Control system commissioning shall be performed for each HVAC system. Deliver the report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

### 1.6.3 Performance Verification Test

Compliance of the HVAC control system with the contract documents shall be demonstrated. Using test plans and procedures previously approved by the Government, demonstrate all physical and functional requirements of the project, including communication requirements. The performance verification test procedures shall explain, step-by-step, the actions and expected results that will demonstrate that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on the Contractor's written certification of successful completion of Contractor site testing as specified and upon successful completion of the training as specified. The PVT shall be performed only after all HVAC air-system and hydronic-system balancing has been completed, minimum damper positions set and a report has been issued. Commissioning may be performed prior to or simultaneous with HVAC system balancing.

### 1.6.4 Endurance Test

The Contractor shall use the endurance test as specified to demonstrate the specified overall system reliability requirement of the completed system. The endurance test shall not be started until the Government notifies the Contractor in writing that the performance verification test is satisfactorily completed. The Government may terminate the testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing. All equipment provided under this specification section shall operate in accordance with the contract requirements for the duration of the test.

1.6.4.1 Duration of Test

The test shall be conducted 24 hours per day, 7 days per week, for 8 consecutive calendar days, including holidays, and the system shall operate as specified.

1.6.4.2 Assessment

After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and test review meeting, the Government may require that the Phase I test be totally or partially rerun. After the conclusion of any retesting which the Government may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

1.7 SERVICE QUALIFICATIONS

The equipment items shall be supported by a service organization. Submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be within 4 hours travel time from the installation site on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. All materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in a satisfactory commercial or industrial use for 2 years prior to use on this contract. The 2 years' use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6,000 hours exclusive of the manufacturer's factory tests, can be shown. Identical items of the same type and purpose shall be identical, including equipment, assemblies, parts and components. Automatic temperature controls shall be direct digital controls that will provide the required sequence of operation.

2.1.1 Electrical and Electronic Devices

All devices not located within an HVAC control panel shall have a NEMA ICS 1 enclosure in accordance with NEMA 250 unless otherwise shown.

2.1.2 Standard Signals

Except for air distribution terminal unit control equipment, the output of all analog transmitters and the analog input and output of all DDC panels shall be 4-to-20 mAdc signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

2.1.3 Ambient Temperature Limits

All DDC panels shall have ambient condition ratings of plus 35 to 120 degrees F and 10 to 95 percent relative humidity, noncondensing. All devices installed outdoors shall operate within limit ratings of minus 30 to 150 degrees F. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

2.1.4 Wiring

2.1.4.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.1.4.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum and shall be rated for 300-volt service.

2.1.4.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 14 AWG minimum and shall be rated for 600-volt service.

2.1.4.4 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single or multiple-twisted, minimum 2-inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20-AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20-AWG tinned-copper cable drain wire, and overall cable insulation.

2.2 FIELD INTERFACE HARDWARE

### 2.2.1 Actuators

#### 2.2.1.1 General Requirements

Actuators shall be electronic/electric type with built-in feedback. Drive motor shall operate on 24 VAC. Actuator shall be controlled with a 0 to 10 VDC or 4 to 20 MADC input signal from an electronic controller. A built-in microprocessor shall automatically test for the amount of rotation required to modulate the device fully closed to fully open. The actuator shall self adjust to run a consistent running time of 150 seconds and rescale the input signal so the entire 8 volt control range is used to provide maximum resolution of the control system. It shall also correct for compression of tight close-off gaskets with age. A manual override button shall allow functional test of the assembly. A 2 to 10 VDC feedback shall be provided with full 8 volt output range and shall be wired to the DDC controller for position indication. Auxiliary switches shall be easily fastened directly onto the actuator body for signaling and switching functions.

#### 2.2.1.2 Damper Actuators

Actuators shall smoothly operate the devices to which they are applied. Actuators shall fully open and close the devices to which they are applied. The actuator stroke shall be limited by an adjustable stop in the direction of power stroke. The actuators shall be provided with mounting and connecting hardware.

#### 2.2.1.3 Valve Actuators

Valve actuators shall be selected to provide a minimum of 125 percent of the motive power necessary to operate the valve over its full range of operation.

### 2.2.2 AUTOMATIC CONTROL VALVES

#### 2.2.2.1 Valve Assembly

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv.

#### 2.2.2.2 Butterfly-Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service, and for modulation to the fully-closed position, with carbon-steel bodies and noncorrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from minus 20 degrees to plus 250 degrees F. Valves shall have a manual means of operation independent of the actuator.

#### 2.2.2.3 Two-Way Valves

Two-way modulating valves shall have equal-percentage characteristics.

2.2.2.4 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

2.2.2.5 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be furnished for each flare-type end valve.

2.2.2.6 Valves for Chilled-Water

Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze or iron. Bodies for 2-inch valves shall have threaded ends. Bodies for valves from 2-1/2 inches to 3 inches shall have flanged-end connections. Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal valve trim shall be brass or bronze except that valve stems may be type 316 stainless steel. Valves 4 inches and larger shall be butterfly valves.

2.2.2.7 Valves for Hot-Water Service Below 250 Degrees F and Dual Temperature Service

Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for 2-inch valves shall have threaded ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal trim (including seats, seat rings, modulating plugs, and springs) of valves controlling water hotter than 210 degrees F shall be Type 316 stainless steel. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher. Valves 4 inches and larger shall be butterfly valves.

2.2.2.8 Valves for Steam Service

Bodies for valves 1-1/2 inches and smaller shall be all brass or bronze, with threaded or union ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for valves 4 inches and larger shall be iron. Bodies for 2-inch valves shall have threaded ends. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be not less than shown nor greater than the Cv of the manufacturer's next larger size. Internal valve trim shall be Type 316 stainless steel.

2.2.3 DAMPERS

2.2.3.1 Damper Assembly

A single damper section shall have blades no longer than 48 inches and shall be no higher than 48 inches. Maximum damper blade width shall be 6 inches. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. All blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section will not be located directly in the air stream. Damper axles shall be 0.5 inch (minimum) plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 fpm in the wide-open position. Frames shall not be less than 2 inches in width. Dampers shall be tested in accordance with AMCA 500.

2.2.3.2 Operating Links

Operating links external to dampers (such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers) shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

2.2.3.3 Outside-Air, Return-Air, and Relief-Air Dampers

The dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 20 cfm per square foot at 4 inches water gauge static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 degrees F to 200 degrees F. Dampers shall be rated at not less than 2,000 fpm air velocity.

2.2.3.4 Mechanical and Electrical Space Ventilation Dampers

The dampers shall be as shown. Dampers shall not leak in excess of 80 cfm per square foot at 4 inches water gauge static pressure when closed. Dampers shall be rated at not less than 1,500 fpm air velocity.

2.2.3.5 Smoke Dampers

Smoke damper and actuator assembly required per NFPA 90A shall meet the Class II leakage requirements of UL 555S. Dampers shall be rated at not less than 2500 feet per minute air velocity.

2.2.3.6 Combination Fire/Smoke Dampers

Fire/smoke damper and actuator assembly required per NFPA 90A shall meet the Class 1 leakage requirements of UL 555Sand minimum hour rating equal to the wall it passes through per UL 555. Dampers shall be rated at not less than 2500 feet per minute.

2.2.3.7 Damper End Switches

Each end switch shall be a hermetically-sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

2.2.4 Smoke Detectors

Smoke detectors shall be as specified in Section 16721, FIRE DETECTION AND ALARM SYSTEM.

2.2.5 Instrumentation

2.2.5.1 Measurements

Transmitters shall be calibrated to provide the following measurements, over the indicated ranges, for a linear output of 4 to 20 mAdc:

a. Conditioned space temperature, from 50 to 85 degrees F.

b. Duct temperature, from 40 to 140 degrees F.

c. Chilled-water temperature, from 30 to 100 degrees F.

d. Dual-temperature water, from 30 to 240 degrees F.

e. Heating hot-water temperature, from 100 to 250 degrees F.

f. Condenser-water temperature, from 30 to 130 degrees F.

g. Outside-air temperature, from minus 30 to 130 degrees F.

h. Relative humidity, 0 to 100 percent for high-limit applications; from 20 to 80 percent for space applications.

i. Differential pressure from 0 to 2.0 inches water gauge.

j. Pitot-tube air-flow measurement station and transmitter, from 0 to 0.1 inch water gauge for flow velocities of 500 to 1,200 fpm, 0 to 0.25 inch for velocities of 500 to 1,800 fpm, or 0 to 0.5 inch for velocities of 500 to 2,500 fpm.

2.2.5.2 Temperature Instruments

a. Room Temperature Sensors

Sensing element shall be 10,000 Ohm at 77 Deg F. The thermistor shall have an end to end accuracy of 0.076 Deg F, a 0.36 Deg F maximum error, and a maximum drift per year of 0.045 Deg. F.. Wall mounted bases shall flush mounted on wall box. White plastic enclosure covers shall be tamper resistant with LCD room temperature display, set point adjuster and pushbutton for occupied mode override.

b. Temperature Transmitters

The transmitters shall be selected to match the resistance range of the sensors. The transmitter shall be a two-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required temperature measurement. The output error shall not exceed 0.1 percent of the calibrated measurement. The transmitter shall include offset and span adjustments.

2.2.5.3 Relative-Humidity Instruments

Temperature compensated polymer capacitance sensor with NIST traceable 2% accuracy. Wall base shall be flush mounted on wall box with white plastic cover. Duct mounted transducers shall be in NEMA 4 steel enclosure. Output shall be 4-20MA, 0-5VDC, or 0-10VDC selectable. Non-interacting zero and span trimmers. The sensor shall be wall mount type or duct mount type as appropriate and shall be provided with the required accessories. Duct sensors shall be provided with duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Sensing elements shall have an accuracy of plus or minus 2 percent of full scale within the range of 20 to 80 percent relative humidity.

2.2.5.4 Differential Pressure Instruments

The instrument shall be a pressure transmitter with an integral sensing element. The instrument over pressure rating shall be 300 percent of the operating pressure. The sensor/transmitter assembly accuracy shall be plus or minus 2 percent of full scale. The transmitter shall be a two-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required pressure measurement. Each transmitter shall have offset and span adjustments.

2.2.5.5 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 2-inch lagging neck and extension-type well, and inside diameter and insertion length as required for the application.

2.2.5.6 Sun Shields

Sun shields for outside-air temperature sensing elements shall prevent the sun from directly striking the temperature sensing elements. The Sun shields shall be provided with adequate ventilation so that the sensing element responds to the ambient temperature of the surroundings. The top of each sun shield shall have a galvanized-metal rain shield projecting over the face of the sun shield. The Sun shields shall be painted white.

2.2.6 Thermostats

2.2.6.1 Freezestats

Freezestats shall be manual reset low-temperature safety thermostats, with NO and NC contacts and a 20-foot element which shall respond to the coldest 18-inch segment.

2.2.7 Pressure Switches and Solenoid Valves

2.2.7.1 Pressure Switches

Each switch shall have an adjustable setpoint with visible setpoint scale. Range shall be as shown. Differential adjustment shall span 20 to 40 percent of the range of the device.

2.2.7.2 Differential-Pressure Switches

Each switch shall be an adjustable diaphragm-operated device with two SPDT contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. These fittings shall be of the angled-tip type with tips pointing into the air stream. Range shall be 0.5 to 6.0 inches water gauge. Differential shall be a maximum of 0.15 inch water gauge at the low end of the range and 0.35 inch water gauge at the high end of the range.

2.2.8 Air Flow Measuring Stations:

Provide single device in each outside air intake ducts with multiple electronic points for sensing airflow for indoor air quality purposes.

2.2.9 Output Devices

2.2.9.1 Relays

Control relay contacts shall have utilization category and ratings selected for the application, with 1 or 2 sets of contacts as required enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

2.3 DDC CONTROL PANEL ENCLOSURE AND FIELD CONTROL HARDWARE

A DDC control panel enclosure shall be provided for the location shown on the drawings. Enclosure shall be a single NEMA 250, Type 4 Hoffman or equal enclosure with continuously hinged doors, key locked, with instrument rear stand-off panel, full height front swing out panel (with cutout only for digital displays and keypads), 2X3-inch wiring gutter, 120VAC receptacle, floor mounting legs, and white interior enamel paint. Each enclosure shall be sized to accommodate the equipment to be mounted inside the panel and to fit the space available a with minimum.

All components of each building system to include standalone digital controller and/or ancillary digital controllers, global control module, LAN interface module, modem, automatic fax/modem switch, and power supplies shall be mounted and factory wired inside the respective mechanical room panel enclosure. Interposing relays and 120/24VAC control voltage transformers shall be provided to isolate line voltage starters from the DDC control panel enclosure devices.

All selector switches, relays, and relampable indicating lights shall be as manufactured by the Square D Company, Class 9000 heavy duty oil-tight or equal. Selector switches, analog indicators and indicating light shall be mounted on the front swing out panel. A Hand-Off-Auto control switch shall be provided on the swingout panel for each fan and pump electric motor. Only low voltage control and signal circuits shall be permitted inside the control panel. A 24VAC transformer shall be provided for each motor starter for manual HOA switch control.

All interior and exterior mounted devices shall be provided with black lamicoid name tags with 1/8" white letter mechanically fastened to the surface.

Field wiring may be connect directly to ADC or SDC terminal blocks. Screw terminal strips with compression type ring terminal lugs shall be provided in the panel for all other field mounted devices.

A minimum of 4 inches shall be provided between all internal system components mounted in the enclosure.

All panel internal wiring shall be with type gray or colored SIS, single conductor, minimum 16 gage, 26 strand, 90 deg.C., crosslinked polyethylene switchboard wire. All wiring shall be routed in open slot wiring duct with covers. All wiring shall be tagged on both ends with same numbers to appear on schematic drawings.

Complete schematics with all devices terminal numbers and terminal strips numbers shall be provided.

2.3.1 Standalone Digital Controllers (SDC)

Standalone Digital Controllers (SDC) shall be 16 bit microcomputer based, utilizing a multi-tasking, multi-user operating system. The SDC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board SDC controller database shall be performed on-line using the built-in or HHOT interface. Systems which require the SDC to be removed from service while DDC control sequences are modified are not be acceptable. SDC controllers shall utilize true floating point arithmetic capabilities. To accommodate totalization of large totalized values, SDC's with reporting capability shall support the calculation, accumulation and display of values within the range of +/-10 to the 10th power.

2.3.1.1 Database and Memory Back-Up

All programming defining the functions to be performed by the SDC, including but not limited to application programs and point database within each SDC, shall be protected from loss due to power failure for a minimum of six months. Systems providing non-volatile memory for these functions are preferred. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6 month period. Systems not in compliance shall provide for uninterrupted power to each SDC.

2.3.1.2 Service Ports

SDC controllers shall be equipped with a minimum of one operator service port for the connection of a HHOT. The service port shall be either a built-in RS-232 data terminal port or an RJ-11 type jack which connects to the manufacturer's standard HHOT. Connection of a service device, to a service port, shall not cause the SDC controller to lose communications with its peers or other networked device controllers. The service port shall allow utilization of the same HHOT from any location. The same HHOT shall be utilized for any SDC or ADC Systems which utilize more than one variety of HHOT shall not be acceptable.

2.3.1.3 Display and Readout Capability

The SDC controller shall provide a built-in operator interface which consists of an alphanumeric LCD display of 4 lines x 20 characters, and a multi-function keyboard. Devices without such built-in displays shall provide a permanently connected HHOT paragraph 2.4.4. The SDC controller shall additionally provide diagnostic LED indication of device transmit and receive data communications for all communication port and peripheral ports, normal operation, abnormal operation and control relay operation indication.

2.3.1.4 Commanded Override

The SDC controller shall provide commanded override capability from the HHOT or the built-in operator interface. Such overrides shall be annunciated to the CHS's and shall be valid as long as power is applied to the controller.

2.3.1.5 Manual/Auto Control and Notification

2.3.2 Manual Hand/Off/Auto Switches

Manual Hand/Off/Auto switches shall be provided and mounted on the swing out panel of the DDC panel enclosure.

Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual SDC. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the SDC. From a single SDC user interface, any other SDC shall be accessible and full adjustment capabilities shall be provided.

2.3.3 Spare Point Capacity

Digital controller based control panel bids shall include in every panel, additional capacity for future installation of desired equipment, at the owner's discretion. Provide expansion capacity of at least 10% for every panel. Any Input/Output cards or modules required to utilize the spare points shall be provided. Expansion capacity shall include equal quantities of every point type; Analog input, Digital input, Digital output, and Analog output. Systems providing modulating outputs via pulse width modulation techniques, shall provide within each panel all the components required to implement the functions equivalent to an analog output.

2.3.4 Sensing Requirements

All sensing inputs shall be provided via industry standard signals. All signal inputs shall be compatible with the controllers used, and with the requirements for readout of variables in true scaled engineering units as specified. Temperature, humidity, differential pressure, and other signal inputs shall be one of the following types:

0-20 mA
4-20 mA
0-5 VDC
0-12 VDC
1000 ohm platinum (at OC, 2.62 ohms/ C)
1000 ohm Balco (2.2 ohms/F)
10 k ohm Thermistor (at 25C/77F)

2.3.5 Control Output Requirements

2.3.5.1 On/Off Outputs

Control panel shall internally provide test points for the circuit driving the equipment contactor, for the purpose of troubleshooting the 120 VAC or 240 VAC circuit to the contactor. All such relays or digital output modules shall provide a pilot light or LED display of this same status. On/Off output modules shall be of the modular construction that can be easily and quickly replaced, on an individual basis, if the module were to be damaged.

2.3.5.2 Modulating Outputs

Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC with definable output spans, to adapt to industry available control products. Milliamp outputs of 0-20 mA or 4-20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable provided that they also comply with the following requirements.

All modulating outputs shall provide within the control panel, a meter gauge, or display indication via on board display or HHOT, the commanded position signal for the actuating device. This meter, gauge, or display must provide either a 0-100 percent position indication, or read out directly in the engineering units of the signal being used. Drive open/drive closed type controllers shall include sufficient components and control algorithms to comply with this requirement. In the case of Drive open/closed technology, position feedback shall be provided to insure positive indication that the control device is at the commanded position.

2.3.6 Ancillary Digital Controller (ADC)

Controls shall be microprocessor based, Ancillary digital Controllers (ADC's). ADC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the ADC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the owner. If the input points are not fully universal in nature, unused points must be equal in quantity between Analog Inputs and Digital Inputs.

The BAS contractor shall provide and field install all ADC's specified under this section. Mechanical equipment manufacturers desiring to provide ADC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.

All input/output signals shall be directly hardwired to the ADC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

ADC's shall be in continuous direct communication with the network which forms the facility wide Building Automation System. The ADC's shall communicate with the SDC at a baud rate of not less than 19,200 baud.

2.3.6.1 Non-Volatile Memory

All control sequences programmed into the ADC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the ADC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The ADC shall allow for the creation of unique application control sequences. Systems that only allow selection of sequences from a library or table, are not acceptable.

All control sequences shall be fully programmable at the ADC, allowing for the creation and editing of an application control sequence, while at the unit.

2.3.6.2 HHOT Interface

The ADC shall be provided with an interface port for the HHOT. The interface port shall allow the HHOT to have full functionality as described in this specification. From the interface port, the HHOT shall be able to directly access any ADC in the network.

2.3.6.3 Point Trending

The ADC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples, per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days. Systems unable to provide the above capability shall provide for the individual Input/Output point trending at the SDC. Specifics as to how each ADC point will be trended, at the SDC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the SDC and the number of ADC's per SDC that can be expected.

2.3.6.4 Indicators

The ADC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.

2.3.6.5 Time Clock

The ADC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the ADC, without loss of setting. The battery for the time clock shall be replaceable by the customer. The ADC shall be provided with integral time schedules; as a minimum, two seven day schedules with eight on/off periods per day shall be provided. Holiday override of weekly schedules shall be provided for pre-scheduling of holidays, for the year in advance.

2.3.6.6 Controller Location

The ADC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The ADC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

For compatibility to the environment of the air handling unit, ADC's shall have wide ambient ratings. ADC's shall be rated for service from -40 Deg F (Degrees Fahrenheit) to 140 Deg F.

Contractor shall submit description of location of ADC's on all mechanical and air handling equipment.

2.3.7 Unitary Digital Controller (UDC)

2.3.7.1 General

Controls shall be microprocessor based. UDC's shall be provided for air terminal units and other applications as shown on the drawings. UDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the UDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. Contractor shall provide a minimum of one UDC controller per unitary system as shown on the drawings.

2.3.7.2 Input/Output Interface

All input/output signals shall be directly hardwired to the UDC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

2.3.7.3 Communications Interface

UDC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The UDC's shall communicate with the SDC at a baud rate of not less than 9,600 baud.

2.3.7.4 Non-Volatile Memory

All control sequences programmed into the UDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the UDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The UDC shall allow for the creation of unique application control sequences. Systems that allow only selection of sequences from a library or table are not acceptable.

All control sequences shall be fully configurable at the ADC, allowing for the creation and change of a sequence while at the unit.

2.3.7.5 HHOT Interface

The UDC shall be provided with the ability to interface with the HHOT. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the HHOT to have full functionality as described in this specification. From the interface port, the HHOT shall be able to directly access any ADC in the network.

2.3.7.6 Input/Output Trending

The UDC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. Systems unable to provide the above capability shall provide for the individual input/output point trending at the SDC. Specifics as to how each UDC point will be trended, at the SDC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the SDC and the number of UDC's per SDC that can be expected.

2.3.7.7 Indicators

The UDC shall provide LED indication of transmit/receive communication performance, as well as for the proper/improper operation of the controller itself.

2.3.7.8 Controller Location

To simplify controls and mechanical service troubleshooting, the UDC shall be mounted directly in the controls compartment of the unitary system. The UDC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL 465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The UDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling. Contractor shall submit description of location of UDC's on all mechanical and unitary equipment.

2.3.7.9 Ambient Ratings

For compatibility to the environment of the unitary equipment, UDC's shall have wide ambient ratings. UDC's shall be rated for service from 32 Deg F (Degrees Fahrenheit) to 140 Deg F.

2.3.8 Gateway Digital Controller (GDC)

A. Controls shall be microprocessor based, Gateway Digital Controllers (GDC's). GDC's shall be provided for the purpose of integrating microprocessor based, communicating, direct digital control systems from vendors other than the primary, selected controls manufacturer. GDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the GDC. All communications interface control programs shall be resident within the GDC. The BAS contractor shall provide and field install all GDC's specified under this section. Any interface requirement beyond a two wire communications wire link, shall be provided by the equipment manufacturer supplying the non-primary or third party microprocessor based, communicating, direct digital controllers.

B. All GDC's shall exist at the LAN level with the SDC's. The GDC's shall provide the interface to the third party systems described in 12.13.1.1. The GDC's shall communicate with the third party controllers at the highest possible baud rate offered by the third party system. As a minimum, 19,200 baud communications shall be utilized.

C. All sequences programmed into the GDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The GDC shall allow the standard database information from the third party system to be integrated in standard FMCS data formats, allowing for the creation of unique application control sequences.

## 2.4 FACILITIES MANAGEMENT SYSTEM

### 2.4.1 General

The existing Dyess AFB Facilities Management System (FMCS) is comprised of a network of various independent, Stand-alone Digital Controllers (SDC's) and Ancillary digital Controllers (ADC's); together with Handheld Operator Terminal (HHOT), Telephone Interface (TI), Fiber Optics Local Area Network (LAN) and Centralized Host Stations (CHS) as indicated to provide centralized access and facility wide control functions. The new SDC's, UDC's, and ADC's specified for installation in Bldg 9201 shall be connected by this contractor to the existing dial-up telephone lines and fiber optics LAN's at each building to provide access and sharing of information by the existing FMCS. The temperature control contractor shall provide the types and quantities of CHS, HHOT, TI, SDC, and ADC shown in the drawings in the locations specified.

### 2.4.2 Centralized Host Stations (CHS)

The existing main CHS, located at Bldg 8006, includes all hardware and software components to support the new DDC equipment to be installed in Bldg 9201. The main CHS and two other existing CHS's includes the following:

- 486DX 75MHz computer
- mouse pointing device
- parallel interface printer
- high resolution SVGA color graphics monitor
- auto answer/auto dial modems
- LAN interface adapters
- graphical interface software

Contractor shall reprogram the existing graphical interface software in each of the three CHS to include additions / modifications made by this contract and to provide full capability of the FMCS to monitor and control the DDC in this new building and the buildings presently monitored and controlled.

### 2.4.3 Local Area Networks

2.4.3.1 Commercial and Controller LAN Communication Conventions

The Commercial LAN is an existing Dyess fiber optics, 10 Base-T, and 10 Base-2 network which conforms to the Ethernet industry standard format IEEE 802.4h-1997. It is presently connected to the existing main CHS in Bldg 8006. (The two other existing CHS presently have only modem dial-up capability.) Interfacing capability shall be provided for connection by others from the new DDCS system to the existing Dyess AFB Commercial LAN by way of a GFE hub in Bldg 9201.

The Controller LAN to be provided which will connect the DDCS components within the building shall be manufacturer's standard or available from third party vendors. It utilize the same chip implementation as used by the manufacturer. Industry standard ANSI, RS-485 Network Communication System or Equivalent shall be utilized.

2.4.3.2 Controller LAN Wiring Practices

The distributed controller LAN communication network system shall consist of a multi-drop RS-485 or fiber bus architecture connecting SDC's and ADC's. There shall be no power wiring, in excess of 30 Vac rms voltage, run in conduit with communications LAN wiring. In cases where power or signal wiring is run in conduit with the controller LAN, all communications wiring and power wiring shall be run using separate twisted shielded pairs (24 AWG) with the shields grounded in accordance with the manufacturer's wiring practices. The LAN shall consist of:

A. A twisted pair of wires (24 awg) completely encased in continuous metallic conduit.

B. or a twisted shielded pair of wires (24 AWG) with the shield grounded in accordance with the manufacturer's wiring practices.

C. or a dual channel, 62.5 micron fiber cabling system with ST type connectors.

Use of NEC compliant type CM/CMP cable installed in a concealed space without conduit is permissible.

2.4.3.3 Communications Circuit Transient Protection

Provide a transient surge protection device providing the minimal protection specifications of the General semiconductor Model #422E device on communications wiring at each building entry and exit point. Transient surge protection is not necessary if the communication wiring, external to the building, is fiber optic in nature.

2.4.3.4 LAN Distance

The communications LAN shall provide operation capability over end to end linear distances of 4000 feet for wire connections and 6,500 feet for fiber optic connections, without repeaters, at communication data rates of up to 64 kbps. At data rates of up to 19.2 kbps, the LAN distance shall be extendible to distances of up to 20,000 feet using RS-485 communication wire or fiber optic repeaters. A repeater shall be used each 4,000 feet of linear distance for wire or every 6,500 feet for fiber optics. Repeating devices shall contain separate LED indication for each communication interface LAN to indicate proper operation of the repeater as well as the communications LANs. The LAN may be extended up to 20,000 feet through the use of wire repeaters or 80,000 feet through the use of fiber optic repeaters. Contractors shall provide devices which are of FMCS control system manufacturer's design.

2.4.3.5 Topology

It shall be possible for the LAN to be "T"eed or "starred", at any location using a repeater, to facilitate the installation. Systems which do not provide this capability shall provide a riser diagram showing end to end distances and locations of system topology necessary to meet the diagram shown on the plans. Contractors shall provide devices which are of FMCS control system manufacturer's design.

2.4.3.6 Fiber Optic Communication

a. Fiber Optic Cable

The fiber optic communications shall utilize a single duplex cable containing two fibers (transmit and receive), of 62.5 micron construction, to accommodate data rates of up to 64 kbps.

b. Fiber Optic Modems

Fiber optic cables shall be connected to SDC devices using manufacturer's standard RS-485 to fiber optic data link modems. Repeating devices shall contain separate LED indication for each communication interface and the fiber modem, to indicate proper operation of all aspects of the device. Fiber modem devices shall be tested and conform with transient surge withstand tests for electrical devices, IEEE C62.41,IEEE-587 Categories A and B . Manufacturer's data sheet shall provide evidence of compliance with this requirement. Manufacturer's products which do not meet this minimum performance requirement shall not be acceptable.

c. Gateway Controllers

Systems which require a special gateway controller to accommodate the fiber optic LAN, shall provide such a controller per point where the fiber optic cable enters and leaves the building. Gateway controllers shall not inhibit transfer of point data values between SDC controllers throughout the LAN. Such inhibitive systems are not be acceptable.

d. Direct Fiber Link

In lieu of fiber optic modems or gateway controllers, the contractor may provide a fiber optic link to each SDC controller within the LAN. All controllers shall have access to the fiber optic link for LAN.

2.4.4 Hand Held Operator Terminals (HHOT)

2.4.4.1 HHOT Hardware

The existing GFE HHOT to be used, at minimum, is an IBM PC compatible portable laptop computer with an 804X86 microprocessor, 500MB hard disk, 3.5 IN floppy disk drive, SVGA LCD color display, and RS-232 serial port.

2.4.4.2 HHOT Software

The existing HHOT shall be provided with the latest revision of the manufacturer's standard HHOT software. The HHOT software shall allow the operator to directly connect to any controller within the FMCS. When connected, the HHOT shall allow viewing, editing and programming capabilities for the connected controller or any other controller within the network. The HHOT shall graphically display real time point data or graph trended data within any ADC. The HHOT shall allow off line database creation or editing.

2.5 SYSTEM SOFTWARE DESCRIPTION

Contractor shall provide all software programming for complete and operational systems as described herein.

The existing CHS workstation software shall be configured to operate according to the DDC system manufacturer's specifications. Software capability shall include manufacturer's standard multi-tasking, multi-user operating system for operator consoles and controllers, network communication software for dial-up and LAN applications, operator man-machine interface software, control application software and software necessary to provide the functions specified herein.

2.5.1 Centralized Host Station (CHS) Software

2.5.1.1 Menu System

Provide a menu driven graphical operator interface. The menu system shall allow an operator to select a particular function or access a particular screen through successive menu penetration.

2.5.1.2 Controller Data Base Modification

The workstation software shall be an interface for performing capabilities specified in paragraph entitled "DDC Software" and available through direct connection of a computer to a digital controller. Database modification shall require only that an operator "fill in the blank" for that parameter on a screen requesting the information in plain language. Database modifications shall be automatically downloaded to the appropriate controllers at operator request.

2.5.1.3 Program modification

Systems shall be capable of both block programming and line by line programming.

Block programming languages shall provide a capability for linking blocks together to create new programs or modify existing programs. Each block shall represent a typical hardware device, such as an analog temperature loop controller, signal conditioner, or valve positioner, which has been replace by software functions in the direct digital controller. Each individual block shall appear on screen with all input and output parameters, set points, limits, and control functions indicated. All parameters shall be changeable by entering new or revised information while the blocks are visible on the CRT screen. Program modifications shall be automatically downloaded to the appropriate controllers at operator request.

An off-line text editor, similar to a BASIC program full screen editor, shall be provided for the line-by-line programming, permitting modification of controller resident control programs.

2.5.1.4 Graphic-Based Software

Graphic-based software shall provide graphical representation of the building, the buildings mechanical systems, and the DDC system. The current value and point name of every I/O point shall be shown on at least one graphic and in its appropriate physical location relative to building and mechanical systems Graphics shall follow the style of the control control drawings in representing mechanical systems, sensors, controlled devices, and point names.

2.5.1.5 Graphic Title

Graphics shall have an identifying title visible when the graphic is being viewed.

2.5.1.6 Dynamic Update

When the workstation is on-line with the control system, point data shall update dynamically on the graphic images.

2.5.1.7 Graphic Penetration

Provide graphic penetration when the capability exists. For systems without graphic penetration, provide menu penetration for selection of individual graphics to give the same hierarchical affect provided by graphic penetration.

2.5.1.8 Graphic Types

Graphic-based software shall have graphics of the building exterior, building section, floor plans, and mechanical systems. Provide the following graphics.

a. Building Exterior Graphic: Show exterior architecture, major landmarks, and building number.

b. Building Section Graphic: Show stacked floors in section graphic with appropriate floor name on each floor.

c. Floor Plan Graphics: Provide a single graphic for each floor, unless the graphic will contain more information than can reasonably be shown on a single graphic. Each heating or cooling zone within a floor plan shall have a zone name and its current temperature displayed within the zone outline. Show each controlled variable in the zone. Provide visual indication for each point that is in alarm.

d. Mechanical System Graphics: Provide two-dimensional drawings to symbolize mechanical equipment; do not use line drawings. Show controlled or sensed mechanical equipment. Each graphic shall consist of a single mechanical system; examples are a graphic for an air handling unit, a graphic for a heating water system, and a graphic for a chiller system. Place sensors and controlled devices associated with mechanical equipment in their appropriate locations. Place point name and point value adjacent to sensor or controlled device. Provide visual indication of each point in alarm. Condition, such as zone temperature, associated with the mechanical system shall be shown on the graphic. Point values shall update dynamically on the graphic.

e. All field survey, research, and verification of drawings of the existing floorplans and existing equipment arrangement shall be provided by the contractor.

2.5.1.9 Graphic Editing

Full capacity as afforded by a draw software package shall be included for operator editing of graphics. Graphics may be created, deleted, and modified, and text added.

Provide capability to store graphic symbols in a symbol directory and incorporate these symbols into graphics. A minimum of sixteen colors shall be available.

2.5.1.10 Dynamic Point Editing

Provide full editing capability for deleting, adding, and modifying dynamic points on graphics.

2.5.1.11 Trending

Trend data shall be displayed graphically, with control variable and process variable plotted as functions of time on the same chart. Graphic display of trend data shall be a capability internal to the workstation software and not a capability resulting from download of trend data into a third-party spreadsheet program such as Lotus, unless such transfer is automatic and transparent to the operator, and the third-party software is included with the workstation software package. At the operator's discretion trend data shall be plotted real time.

2.5.1.12 Graphical Operator System Interface

Each terminal shall be driven by software which displays all information in graphical and textual formats. The operator shall access any information via a command prompted, mouse driven interface. The operator shall be able to penetrate to any level of desired system information without being required to enter any commands from the keyboard.

The software shall allow an inexperienced operator to penetrate to any desired system operation using a hierarchical plan of system graphical or textual displays. The Contractor shall provide a logical penetration of graphical displays with the following hierarchical levels:

All system commands shall be graphically displayed using iconic, pulldown, pop-up or graphical data entry templates. Each command selection shall display an advisory description of the commands operation to inform the operator of the expected result.

An on-line message located in a dedicated window at the bottom of the display shall advise the operator of the expected operator action to be performed. Examples include "enter data", "select item from list", etc. In the event of a mouse failure, the operator shall be able to continue operation of the system using the keyboard cursor arrow keys and Alpha characters, as command selections.

At all levels of operation, a dialog box containing context sensitive help messages shall be available by direct command through a single mouse command button.

2.5.1.13 Overall Site Plan

This display shall provide a graphic representation of the overall site plan showing all buildings in the project scope. It shall be possible to add additional buildings to this plan while on-line. Transfers to buildings screens shall be provided.

2.5.1.14 Building

The contractor shall provide a graphic representation of each building within the site. Each screen shall contain transfers to each floor and major mechanical equipment areas within each building as well as back to the overall site plan. All buildings files shall be contained within one design image file for ease of future modification.

2.5.1.15 Floor Area

The contractor shall provide a graphic floor plan of each building floor section shown on the building prints. Each floor plan graphic shall be a design file containing all graphical displays associated with that floor.

Each temperature zone within the floor plan graphic shall be dynamically color coded to depict the comfort conditions on the floor in relationship to the zone temperature setpoints. At a minimum, it shall be possible to color code each region with up to fifteen colors ranging from blue (cold) to green (normal) to red (hot). Each zone shall also have its operating setpoint and current dynamic value displayed. Up to 25 such regions shall be displayed per floor plan.

2.5.1.16 Mechanical Systems

The contractor shall provide a graphical schematic for each mechanical system shown on the drawings. Each sensed or controlled physical point shall be dynamically displayed. In addition, the following information shall be provided:

a. Operating schedule of plant equipment.

Accumulated runtime of all rotating machinery such as fans, pumps and compressors.

b. Operating control sequence priority.

For each variable volume fan or variable speed pump, the fan symbol shall change color according to its relationship to operating setpoint.

c. The color schedule shall be displayed on each screen, for reference.

For each temperature control loop within a fan system the duct work for the region (e.g., mixed air, discharge air) shall change color to dynamically represent conditions.

d. The color schedule shall be displayed on each screen, for reference.

For each temperature control loop in a chiller or boiler plant schematic, the pipe region from the chiller or boiler to the header shall dynamically change color according to the same schedule used by the air handling systems.

It shall be possible to edit the limits at which the dynamic colors change state while the CHS software continues to monitor the FMCS.

2.5.1.17 Real Time Monitoring and Process Control

The system shall provide operator interface software with all capabilities described herein at no additional cost to the Owner.

2.5.1.18 Dynamic Instrument Displays

For any real time process variable displayed on the color graphic display, the contractor shall provide software to display the value as a dynamic bar chart instrument. The instrument shall have a definable minimum and maximum scale, up to 3 definable setpoints such as setpoint and high and low limits. As the process variable value crosses a setpoint threshold, the instrument shall change colors per the user definition.

2.5.1.19 Graphical Energy Consumption Display

The contractor shall provide a graphic display which displays the current power consumption conditions of the building. The display shall contain the following information:

1. Demand Control Setpoints (up to 4) and scheduled hours of operation.
2. Current Demand Setpoint (in kW).
3. Current Building Demand (for each Meter) (in kW).

4. Total Demand (in kW).
5. Maximum Demand this month.
6. Demand Shed Table Status.
7. Totalized Power Consumption for the Day (kwh).
8. Totalized Power Consumption for the Month (mwh).

The operator shall be able to change demand setpoints at any time and override the status of any demand shed load.

2.5.1.20 Unattended Cycle

The system shall also provide an unattended "cycle" feature for low level operators or security personnel use. The cycle feature shall be invoked from any graphic screen, causing the dynamic monitor screens to cycle through the transfer list from the initiating screen, at a user defined interval.

Each screen, when displayed, shall present real time data for the specified interval, allowing a low level operator to determine if problems are present, by use of the dynamic color coded fields or dynamic data displayed on the screen.

The "cycle" feature shall provide a user invocable, automatic print function, providing hard copy reports of each dynamic monitor screen as it is cycled through.

2.5.1.21 Real Time Dynamic Trending

The Real Time Monitoring System shall provide software which produces dynamic x-y axis plots of process control variables, in real time. This software shall not require the user to pre-define any graphs or symbols prior to its use. Systems which require pre-definition of real time trends shall provide a real time trend for every analog point and setpoint in the system at no additional cost to the owner, at time of job start-up.

The real time trend program shall permit the operator, from any process monitoring screen, to select up to 8 process variables from that screen to be dynamically trended in real time. In anticipation that the operator may desire to trend a given value from a graphical or textual monitor screen, the DYNATREND feature shall automatically store all points on a graphic screen, as a background task, while the screen is preset on the video display. This background storage of data shall continue at the predefined intervals for as long as the screen is displayed. The viewing of any points, up to 8 at a time, shall not interrupt the retrieval and storage of the values for the other points on the graphic screen.

When the full set of samples is displayed, the display shall automatically, continuously redraw the trend using the most recent set of samples and allowing old data to shift off the screen to the left. The time of the first and last sample shall always be displayed.

At any time, the operator shall be able to print out a hard copy of the Dynamic Trend using the Print Screen Function.

At any time, the operator shall be able to return to the associated dynamic process screen to adjust setpoints, throttling ranges, etc. without suspending DYNATREND. Upon return to the trend display, it shall be updated to allow the operator to see the impact of changes.

2.5.1.22 System Operations

The Contractor shall provide all software necessary to permit an operator of allowed privilege level to make the necessary setpoint changes, schedule changes and overrides necessary to perform the automated operation of the buildings controlled by this system.

The operator shall be able to acknowledge any alarm from this sub-system with one keystroke. Systems which require an operator to select another sub-system to acknowledge alarms, shall not be acceptable.

An operator shall be able to switch to the alarm processing sub-system for further analysis of alarms with one command.

An operator of sufficient skill shall be able to select any process monitoring screen with a single command to eliminate the need to traverse a hierarchical tree. To assist the operator, an index of all process screens with a speed selection index shall be provided when accessing this command.

For all operations within real time monitoring and process control, a Dialog Help window with on-line context sensitive help messages shall be accessible by a single mouse control button function.

The operator shall be able to obtain a hard copy printout of any screen using the Print Screen command, at any time, to provide real time snapshots of building operational conditions to service personnel. Color graphic screens shall be translated to black/white/grey for black ribbon printers via a pop-up color conversion table.

The software shall automatically provide dial-up capabilities to remote sites when a process display is selected without requiring the operator to select a phone number from a directory or initiate dialing operations. Remote site dynamic displays shall update process displays automatically.

2.5.1.23 System Modifications

The Contractor shall provide all creation, modification and editing software tools necessary to permit a properly trained Owner to modify this sub-system to the buildings needs.

The software shall be provided complete with symbol libraries of ASHRAE standard mechanical systems, sensors, actuators and common electrical systems and components.

It shall be possible to create custom symbols, floor plans, schematics, etc. as necessary, to suit the site specific needs.

The software shall provide capability to create a minimum of 4000 dynamic graphic process screens. The software shall provide capability to display a minimum of 200,000 dynamic data values.

2.5.1.24 Global Equipment Master Scheduling (GEMS)

For each GEMS package, the Contractor shall provide a graphical screen showing the set of global data to be transmitted to multiple sites or pieces of equipment within a site. Examples of these schedules are:

The normal operating occupancy hours for facilities.

The special event or holiday schedules.

The summer/winter setpoints for all facilities.

For each GEMS schedule shown in the drawings, the Contractor shall assign a named group of sites or pieces of equipment to be controlled.

The GEMS package shall permit the operator to make changes to the scheduled data. Upon execution of a single command, the GEMS package shall automatically initiate dial-up or LAN communications with all associated sites or controlled equipment and download the changes into the respective controllers without further operator intervention.

The GEMS package shall support automatic downloading of programs to 250 sites minimum. The GEMS operation shall function as a background task when invoked, and other CHS operations shall be performed concurrently, including operator interaction with other CHS functions during the GEMS execution in the background. The Historical Data Log shall maintain a record of any GEMS changes initiated. It shall be possible for a suitably trained operator to create, edit, modify or delete GEMS schedules.

2.5.1.25 Global Electrical Demand Limiting (EDL)

The Global Demand Limiting Program shall be accessible from the color graphic display.

The Global EDL program shall allow the operator to review and modify all parameters affecting global demand control including Time-of-Day Demand Setpoints, Time-of-Day Periods and Shed Tables. The Global EDL control shall reside at the SDC level. Systems that utilize the CHS for Global EDL are not acceptable.

The Contractor shall provide a minimum of one EDL load shed table per (building wide) SDC controller, but not less than 64 loads per system.

The EDL program at the SDC shall utilize a sliding demand window control algorithm with provisions for multiple load shed tables.

The EDL program shall shed loads according to one of the three following methods:

All loads assigned to a temperature adjustment method shall be shed according to the least deviation from operating setpoint.

All loads assigned to a priority shed table shall be shed on a first off, last on basis.

All loads assigned to a rotating shed table shall be shed on a first off, first on basis.

Each of these three methods shall be considered one table in the global EDL program.

2.5.1.26 Exception and Alarm Processing System (EPS)

The Contractor shall provide CHS Exception Logging, Alarm Processing and Report Generation software as described herein. The software shall be installed to report all alarms and system exceptions for all locations included with this contract. The software shall automatically support the addition of new sites and database modifications as they are made in the future by the Owner.

a. On-Line Status

The Exception Processing System (EPS) shall maintain a continuously displayed Advisory Window on the CHS terminal, at all times, except when the CHS is executing DOS programs which monopolize the screen. This window shall display the current time and date, the number of unacknowledged exceptions (up to 2000), the highest priority most recent exception, and the alarm message of such exception if available.

If there are mail messages for the current user, a mail message advisory shall be displayed until the mail application is accessed.

The alarm messages shall appear in red. The unacknowledged exception counter shall appear in yellow.

If a user is within DOS shell programs, the Exception Processing System shall archive alarms to disk and provide hard copy output to the dedicated alarm printer. Operation of DOS programs or any other Host task shall not suspend operation of the Exception Processing System.

b. Advisory Reports (Automatic)

The Exception Processing System (EPS) shall automatically provide on a user selectable daily or weekly basis, at a user specified time, a report printout of all acknowledged alarms.

The EPS shall automatically provide on a user selectable daily or weekly basis, at a user specified time, a report printout of all unacknowledged alarms. At time of printing, alarms shall be able to be placed into a mass archive file for future reference.

The EPS shall provide a Current Alarms Summary that is displayed automatically whenever the operator accesses the alarm section. Alarms shall be retained in the list as long as the alarm condition has not returned to normal and if the operator has not acknowledged the alarm.

The EPS shall provide up to six additional user configured reports of the exception database which print automatically on a scheduled basis. The reports shall include but not be limited to:

Alarms acknowledged by any operator.

All system overrides which may be initiated from any CHS, CCS or SDC within the BAS system.

All system diagnostics.

c. FMCS Database Maintenance Reports

CHS shall generate a daily report of all modifications made to any software function in the FMCS. Report shall include the fact that specific setpoints, schedules, sequence parameters, or limits were modified and the time and location of the modification, and the identification of the operator making the modification. Report printout shall be operator initiated.

d. FMCS Overrides Report

CHS shall provide a daily report of all overrides issued, and all overrides in force on the FMCS. Overrides report shall allow tracking of operator functions and maintenance of desired operational conditions.

e. Alarm Processing Operations

The EPS shall provide 4 levels of alarm priority separable into 4 classes of alarm processing capabilities.

The lowest level shall be exceptions which are automatically acknowledged by the system and logged to disk (Typically, these are low level system advisories).

The second level shall be alarms which require manual acknowledgment, but are of low level priority. These alarms display their message to the On-Line status window.

The third level shall be alarms which require manual acknowledgment and are printed on the alarm printer. These alarms display their alarm message to the ON-LINE status window.

The fourth level shall be classed as interrupting priority alarms. Interrupt priority alarms shall cause the current operator task to be suspended and control switched to either the Alarm Status Window or to an associated process graphic screen which displays the real time values of the process in alarm.

The priority level of each alarm class shall be user definable.

All alarms and exceptions shall be acknowledged by the operator with one keystroke for simplicity of operation. Additionally, a utility shall be provided that allows the operator to acknowledge multiple alarms in a single command.

Exception messages shall printout to the alarm printer and indicate source of exception, type of exception, time and date of occurrence and exception message.

If an alarm exception returns to normal, a return message shall be printed. When an alarm is acknowledged, the printed acknowledge message shall include the current user's name.

f. Status Log Summary

An On-Line status log shall be provided which contains a prioritized listing of all exceptions. Within each priority, the exceptions shall be listed chronologically. It shall be possible for the user to change this set-up to a chronological listing by priority if desired.

The status log shall indicate, for each exception, the source of the exception, time and date of occurrence, current exception status (alarm, return, acknowledged) and a brief message about the exception as reported by the FMCS controller.

By selecting any one message in the status log and selecting a DETAIL command, the operator shall be given a brief history of the exception including number of occurrences and operator response.

g. Segregation of Alarm Data

The Contractor shall provide a dedicated alarm printer(s) as shown on the drawings and configure the CHS software to print alarms to these output devices. Each alarm class such as HVAC alarms, maintenance alarms and system alarms shall be sent to the devices shown on the drawings.

h. Facsimile Annunciation

The Contractor shall provide the necessary hardware and interface software to allow an alarm occurrence to accomplish the following tasks:

Provide a graphical representation and snapshot of real time process conditions to be sent via facsimile transfer to a facsimile machine located at the selected locations. Facsimile transfer shall be definable to occur upon any Interrupt priority alarm.

Locations shall include:

a} The BAS contractor's designated after hours phone number.

b) The service contractor

c) The building engineers after hours phone number

In addition to the facsimile annunciation, the graphical representation and snapshot of real time process conditions, shall be automatically printed at the designated CHS printer. This capability allows a documented, archiveable copy of the process conditions, at the time of alarm.

2.5.1.27 Report Generation Software

a. Energy Management Reports

CHS shall provide daily, weekly, monthly, yearly formatted reports of facility metered electrical consumption. Reports shall provide information as detailed as hourly KWH consumption, daily peak hour of consumption, daily time of peak demand, demand setpoint in use at time of peak, daily degree days, and outside air temperature and relative humidity at time of peak. Reports shall be created to provide individual reporting as desired by the owner for multiple facility meters, multiple sites, or aggregate facility metering combining multiple meters.

CHS shall retain summary energy data for up to five years. Reports can be designated as automatically printed, or called-up for report print out on demand.

CHS shall support auto dial polling of remote sites for individual energy reporting and histories of multiple sites. CHS provided shall have sufficient capacity to accommodate auto polling and report accumulation of at least 100 sites.

CHS energy report data shall be exportable to other programs in .DIF, .TEXT or .SYLK file formats to allow use by Owner's specialized programs.

b. Trend Reports

CHS shall support logging and historical accumulation of trended data from the entire facility, or multiple sites as required. CHS shall include the capacity for acquiring trend data from at least 250 sites. Each trend report shall display up to 4 system variables with up to 128 samples of each variable displayed. The operator shall be able to define which variables and how many samples will be displayed. The actual trend report data accumulation shall occur at the SDC. The reports, when full at the SDC, shall be uploaded by the CHS for archiving. Systems that do not accumulate the trend data at the SDC shall not be acceptable.

CHS supplied with dedicated logging printers shall provide the capacity to document printed trend data accumulated from any or all of the SDC's in the connected on-site network, or from any number of remote sites which connect to the CHS dedicated logging printer via dial-up modem.

For each trend, up to the capacity of the hard disk resource, it shall be possible to define up to 500 files in a DOS directory for archival storage. The trend archiving software shall automatically create a new file, convert the data to the desired format and store it as specified. CHS trend report data shall be exportable to other programs in .DIF, .TEXT, .SYLK file formats to allow use by Owner's specialized programs.

c. Graphical Chart Plotting and Bar Graph Software

Provide software to be integrated with CHS FMCS software which will enable the operator to command X-Y graphic plots of specific FMCS energy history data or accumulated real-time trend information. Software shall in addition provide bar charts of energy usage information, such as charts of daily peak demand, etc.

The plotting software shall permit the user to select points or values to be plotted, graph type, scale range or auto ranging of scales, legends and report title. Upon selection, the software shall automatically plot without further intervention. The CHS shall continue to monitor and report alarms, reports and other system information while executing plotting software routines.

All graphic plots and bar charts shall be screen printable on to CHS dot matrix or color inkjet printer or color ink pen plotter, where available.

All graphic plots and bar charts shall be convertible into graphic backgrounds that can be displayed in the real time monitor section as a background graphic. The purpose for this feature is the easy archiving of critical plots or charts. The conversion of the chart or plot shall allow for easy viewing at a later date. The quantity of chart or plots that can be archived shall not be less than 100 in quantity at any given time.

d. Third Party Software Packages

CHS shall provide the capability to run specific third party software packages for word processing, spreadsheet generation, or database management. Use of third party software shall operate concurrently with other tasks such as alarm logging, and report data gathering.

The third party software packages shall permit the owner to use any exported data file as input data for customized reports such as tenant billing. As a minimum, the CHS shall support Lotus 1-2-3, Word Perfect, AutoCAD and D-Base III.

e. FMCS Maintenance Report

CHS shall provide a weekly report of maintenance items on an automatic printout basis. The maintenance report shall segregate maintenance items into four categories minimum. A "First Occurrence" report shall be generated for those items which have passed their maintenance limits within the past week. A "Pending" report shall be generated for those items which have been previously annunciated. An "Overdue" report shall be generated for those items which have exceeded their critical past due maintenance settings. A "Work Completed" report shall be generated for those items which have been entered as complete. Maintenance events shall be settable by the user based on event, elapsed run time, number cycles or calendar day/date.

The FMCS Maintenance report generator must extract the performance data directly from the FMCS through communications. The maintenance report generator must be capable of operating concurrently with the other CHS functions without degrading the overall performance of the CHS.

As a minimum, 250 user definable action descriptions shall be assignable to the FMCS Maintenance Reports. Each piece of equipment covered by the Maintenance Report generator shall be tracked for up to five different conditions by a single Maintenance report. Equipment must be grouped into a minimum of 50 categories, with at least 25 pieces of equipment assignable to each category.

Each individual Maintenance Report record shall be logged to the hard disk for future reference. Any existing or past logs shall be printable upon operator request.

Any system unable to deliver the above noted specification as standard product, shall provide a detailed description of the third party Maintenance package that will be delivered as part of the submitted package.

f. Point Summary Data Reports

CHS shall provide software for a minimum of 8 physical point data summary reports.

Each report definition shall be user definable as a group of input/output points.

The Point Data Summary reports shall not be device specific, in that each report can be selectable as any or all input/output points within a building, within several buildings or within all buildings.

Each Point Data Summary report shall be automatically executable on a scheduled daily basis, or upon manual request.

The Contractor shall configure and provide an All Points Status Summary Report which automatically prints out the current value of each physical input and output point on a daily basis. The All Points Status Summary Reports shall be archiveable to the fixed disk, for future reference. This report shall be used to verify end-to-end operation of the system at acceptance and be disabled for normal use, unless requested by Owner's representative to leave enabled following the acceptance process.

2.5.1.28 Database Creation, Maintenance and Diagnostic Utilities Software

The Contractor shall provide the Owner all software necessary to create, maintain, modify and diagnose system operations of the CHS systems and SDC subsystems.

a. User Access

Provide software which allows the Owner to create new users and passwords, modify accessible data privileges of users and restrict access to data as required.

Provide network password control software which restricts users to certain data environments. For example, restriction of security personnel from HVAC control panel functions.

The CHS user access shall be individually definable for each of up to 50 users. Access to specific CHS functions shall range from no access to full programmability. Only the highest level system operator will have access to the user passwords and access information.

A utility shall be provided within the CHS, that allows all FMCS controller databases to be automatically updated with a new user list, via a single command by the operator.

b. Database Creation

(1) SDC Databases

Provide a complete database creation and editing facility for on-line/off-line creation and editing of SDC database. The editor shall contain pre-formatted entry templates of manufacturers pre-tested DDC control and energy management routine libraries.

(2) SDC Database Archiving

CHS shall provide capability to upload global control functions being performed by the network of SDC's, and the individual database and application programming resident in each SDC or ADC in the facility, or on remote sites. Uploaded programs shall be retained on CHS hard disk for system backup. Programs may be modified using CHS Editor functions, and downloaded to individual SDC's as desired. Downloading of SDC databases shall not interrupt alarm reporting functions, or other multi-tasked functions which are ongoing.

Provide software which supports a minimum of 250 sites as standard.

A utility shall be provided that allows any or all of the SDC and MSDC controllers to be automatically downloaded or uploaded with a single operator command.

(3) Real Time Monitoring and Process Control System Database

Provide an On-Line graphics display creation system for the creation, modification and alternation of existing and new process displays. Systems that require the CHS to be taken off line to create or modify graphic process screens, are not acceptable.

Provide digitally scanned photographs as background displays for real time process graphics.

Provide a built-in symbol library of mechanical and electrical systems for use in process graphic creation.

(4) Report Generation Database

Provide all utility software to permit the creation and modification of all reports identified in paragraph 2.6.1.27 Report Generation Software.

c. Dial-Up Systems Support

The Contractor shall provide software which provides dial-up support of a minimum of 250 sites.

The CHS software shall support a minimum of seven auto-answer/auto-dial, 2400 baud asynchronous modems for communications with remote sites. All modems shall be used for incoming alarms, to the CHS, in a primary and Back-Up configuration. Six of the modems shall be used by the CHS as an outgoing communications channel for dial-up communications with remote sites with one modem remaining dedicated to incoming communications from remote sites.

All communications shall occur in the background of the CHS system. Once a remote site access number is programmed into the directory, an operator shall not be required to enter that phone number to initiate communications to the site.

The communications channel shall be monitored and status exceptions generated to the CHS in the event of a communications failure.

The six modems shall be configured in a pool arrangement allowing any of the CHS tasks to access the next available phone line modem. In addition to the seven modems the CHS shall be capable of supporting up to three LAN connected FMCS networks.

Systems unable to accommodate the modem pooling and network connected LANs shall provide sufficient CHS systems to provide an equal dial-in/dial-out modem communication capability.

The multiple modems shall be capable of operating concurrently to allow up to six remote and three local LAN's to simultaneously report realtime data to a graphics process screen. The Contractor shall specify how compliance with this specification item will be accomplished and the performance (update times) results received from testing performed on an actual installed system.

2.5.1.29 Graphical Programming (GP) Software

As an integral function of the CHS, a Graphical Programming (GP) utility shall be provided. All SDC and ADC controllers shall be programmed through the GP utility.

The GP utility shall operate concurrently with the other CHS functions. It shall not be necessary to stop the operation of the CHS to perform the GP functions. At all times, CHS alarm reporting and archiving functionality shall be retained. Systems unable to deliver the concurrent operation of the CHS and the GP shall deliver a separate computer to operate the GP utility. The quantities of individual GP systems shall be equal to the number of GP systems, as defined in the plans.

The GP utility shall utilize standard AutoCAD conventions and shall automatically generate downloadable FMCS controller programs from the graphical flow chart (graphical representation).

All project documentation shall be completed in the same environment. The GP representations of the FMCS controller databases shall be provided in the same format as the submittal drawings for the architecture and the point-to-point wiring.

The intent of this requirement is the consistent and computer resident presentation of all project documentation.

The GP utility shall provide as a minimum the following capabilities:

Library of standard controller application Blocks, allowing the creation of complete controller database.

Full edit capabilities of the attributes for each Block within the application program.

Connect capabilities for interconnection of the application Blocks.

Fixed values settings for user defined values such as setpoints, throttling ranges, PID variables, etc.

Combining functions to allow multiple GP screens to be combined into a single downloadable controller program.

Compare functions that allow uploaded controller functions to be compared against an existing GP database, with the differences between the two application programs broken out in detail for the operator.

Process functions that allow the graphical program to be converted from the flow chart pictorial into the downloadable application program. The process function shall identify all connection errors, naming errors or syntax errors created during the building of the GP. The errors shall be noted, logged to the disk for later review and displayed in a contrasting color on the GP flow chart screen.

As part of the submittal package, the Contractor shall include five unique GP screens depicting systems similar to those in the plans.

All project GP acceptance documentation shall be provided in hard copy format as well as in the soft or disk resident format.

2.5.1.30 Local Area Network Software and Operations

a. Network Shared Data

The FMCS system local area networks shall provide for the sharing of calculated and control point variable values throughout the BAS network. The contractor shall provide all network software links as necessary to provide a complete and functioning system in accordance with the sequences of operation.

b. Network Diagnostics

The CHS and CCS systems shall provide software utilities to determine the on-line status of all network connected controllers (TC, SDC, ADC).

If network connected controller drops off-line, the network software shall detect and annunciate such conditions to the proper output devices.

c. Network Performance

The FMCS communication networks shall provide end-to-end data transmission of all necessary control point values at a minimum rate of that established by standard NFPA-90A.

The nominal network response speed for a data request entered, at a man-machine interface for data contained in another panel, shall not be greater than 30 seconds.

The nominal network response time for an alarm reporting shall not exceed 10 seconds. Ten seconds is the time from when the alarm is initiated to when the CHS receives the message. This specification applies to all SDC's. For ADC initiated alarms, response times shall not exceed 30 seconds, based on the previously described conditions.

d. Hand Held Operator Terminal (HHOT) Software

(1) General

The HHOT software shall be contained on a single floppy disk and operate within the MS-DOS operating system.

(2) Interface

The HHOT software shall display all commands and data entry templates using pop-up, English language menus.

(3) Connectivity

The HHOT software shall allow the same HHOT to be connected to any device type on the FMCS controller network. Connection shall be via a manufacturer's supplied cable interface for all wall sensor locations, ADC and LIDC locations, and an RS-232C cable at all SDC service port locations.

The HHOT shall allow access to all ADC's connected to the network.
The user shall be able to communicate with the ADC's with or without an SDC on the communications bus.

The HHOT shall monitor real time point performance through a real time graphical point display. Analog values shall display as dynamic bar chart values or in dynamic text mode.

The HHOT shall allow the copying of settings such as setpoints and configuration from one device to another.

The HHOT shall permit uploading and downloading of a program from a device to the HHOT magnetic media storage device.

The HHOT shall allow creation and editing of device files off-line.

The HHOT shall allow creation and editing of application control files on-line.

The HHOT shall perform a real time dynamic graphical line trend, in strip chart format, concurrently on a minimum of 2 process values, in user defined sample intervals ranging from 5 seconds to 256 seconds per sample.

The HHOT shall Allow timed or indefinite overrides of any input/output point within the accessed controller. The overridden point shall display on the point status screen as overridden.

The HHOT shall provide system diagnostics and status details regarding the controller input/output points, the controller memory and the controller time clock (if present).

Systems that require the HHOT to be preprogrammed with retrievable data are not acceptable. It is the intent of this specification to provide complete flexibility to the operator when viewing network data. Systems that require pre-definition of information to be retrieved by the HHOT must provide an HHOT at each controller to assure that all controller data throughout the network is available.

2.5.1.31 Stand-Alone Digital Controller (SDC) Software

a. Multi-tasking

SDC operating system software shall be multi-tasking. The multi-tasking capability of the SDC shall provide the capability to simultaneously perform at least, but not limited to, the following functions:

a. Downloading of application program changes to the SDC without affecting the simultaneous operation of existing operating application programming.

b. Printing of scheduled or on-demand reports without preempting operator functions.

b. Standard Software Function Libraries

All SDC's shall have as a standard feature of their system software, complete libraries of control algorithms for DDC, Energy Management, and Facilities Management functions. These resident libraries of algorithms shall be dawn from for the creation of the application programming of each individual SDC.

Controllers which provide custom application software via line-by-line programs shall not be acceptable unless all source and compiled program code is contained in totally non-volatile, but programmable EEPROM memory. Vendors providing line-by-line programmed controllers shall also provide program editors, compilers and de-bugging tools in each SDC panel's EPROM firmware to facilitate the on-line modification of application control sequences.

The Contractor shall utilize these libraries to satisfy the sequences of operation specified in paragraph CONTROL SEQUENCES OF OPERATION. Systems which create these programs utilizing line-by-line programming methods and languages such as PASCAL, BASIC "C" or similar, shall provide the Owner with fully annotated source code of all application software modules used, a 10 year escrow of such source code in a third party location, escrow to be paid up at time of bid.

Each SDC shall be provided with PID control loops that incorporate a self learning capability to eliminate all setup requirements for the Integral and Derivative of the control loop. Each control loop shall be individually tuned. Systems that do not provide automatically tuning loops are not acceptable.

(1) Optimum Start/Stop Control

CHS shall provide operator access to Optimum Start parameters for any designated items or equipment or commonly scheduled systems of equipment. Optimum Start programs shall be self-learning and shall employ adaptive algorithmic parameters to the optimum start/stop calculation for each applied zone. Optimum start/stop shall reside within and be performed by the SDC's. Systems that require the CHS to perform the Optimum Start/Stop control are not acceptable.

(2) Paragraph Not Used

c. Control Panel FMCS Functions

It is the intent of this specification to provide the owner with the ability to read out temperatures and other values, and to adjust specific items from localized, as well as centralized locations. In order to provide this capability, control panels are specified to be placed in specific locations with readout gauges and adjustments to be mounted directly in the control panel.

Every control panel shall provide readouts for the temperatures, or other information specified. Every control panel shall provide adjustments for the setpoints, parameters, and other adjustment functions specified.

(1) Read Out of Items

Items specified for read out shall be under polled, not continuous, display on the face of the panel with either a digital display or analog electronic meter. The contractor shall provide a minimum of 20 values per SDC panel with displays as indicated in the locations shown on the drawings. Read out of sensed variables used in control sequences shall be from the same sensors used for control. As an alternative, provide either a duplicate sensor for the read out, or provide a transducer for each sensed signal which can provide both a read out signal and a signal compatible with the controller.

Each read out item shall be individually named and labeled. Name label shall be directly adjacent to the actual display value of that item including the applicable engineering units. Label shall be a part of the digital display of that value, or a Bakelite label mounted directly above the value display. Display readout requirements are in addition to capabilities provided by plug-in operator devices which are provided as part of digital controller-based systems.

(2) Adjustments

Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be made at each control panel. The preferred method for adjustments is a dedicated adjustment pad, or individual adjustment potentiometers providing direct input to the affected loop controller or sequence controller.

For systems where the Owner is providing a HHOT, the same HHOT unit shall be used at all controller and wall sensor locations throughout the FMCS network. Systems which provide more than one type of HHOT shall not be acceptable.

d. SDC Alarm Dial Out

The SDC system shall provide built-in software with the capability to automatically dial out an alarm to up to 10 remote reporting locations.

The remote reporting location shall be any one of the following which are connected to a phone modem:

A CHS or multiple CHS computer workstations

An ASCII printer

Based on time of day or event initiated programs, the SDC software shall permit an alarm to select any one of three dial-up tables. Each table shall consist of a subset of the 10 phone numbers.

The alarm shall cause the selected table to dial out and report the alarm to all phone numbers listed in the table selected.

Reporting of an alarm to only a single phone number in the table shall not be acceptable as it negates the need to notify the Owner and a service contractor and the person on call, if necessary.

2.5.1.32 Exception Reporting Sequences

a. Alarm/COS Reports

For those analog points indicated on the drawings, the Contractor shall provide a unique high/low limit alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.

For those digital points indicated on the drawings, the Contractor shall provide a unique change-of-state alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.

For those points indicated on the drawings which are designated as interrupt priority, the Contractor shall provide an interrupting process display at the CHS location which displays the current conditions for the operator.

In addition, the CHS computer shall automatically send a picture of the process graphic display to the remote locations specified on the drawings as receiving facsimile copies of interrupting alarms.

For those points designated in paragraph 3 above, the FMCS shall also send a history log to the system report printer of the immediate prior history of the points causing the interrupt priority. This log shall contain 1 minutes samples of the previous 15 minutes of operation.

For those points on the drawings designated as Hard Facts points, the Contractor shall provide an alarm message to a remote facsimile location designated by the Owner. The FMCS system shall provide at the remote location, a facsimile printout showing location, time/date of alarm and alarm message of the point. For interrupt priority fax alarms, the remote facsimile machine shall receive a hard copy of the interrupt process screen showing on-line dynamic data values of the current conditions.

b. Off Hours Exception Reporting

The Owner shall specify up to five sites to which off hours exceptions shall be auto-dialed and reported. This shall allow the owner to assign off hours exception responses to various facility personnel as necessary. Selection of the site to be dialed can be programmed by the Owner, and set to change automatically per time of day and day of week.

2.5.1.33 Direct Digital Control Panel Software

a. Operating System

Each DDC panel shall contain an operating system that controls and schedules that DDC panels activities in real time. The DDC panel shall maintain a point database in its RAM that includes all parameters, constraints, and the latest value or status of all points connected to that DDC panel. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. The operating system shall allow local loading of software and data files from the portable tester and from an operator interface panel.

b. Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the on and off states, ensuring that the correct command will be issued when the time constraint is no longer in effect or report the rejected command. Override command entered by the operator shall have higher priority than those emanating from applications programs.

c. DDC Panel Startup

The DDC panel shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. An DDC panel restart program based on detection of power failure at the DDC panel shall be included in the DDC panel software. Upon restoration of power to the DDC panel, the program shall restart all equipment and restore all loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the DDC panel and if the database and applications software are no longer resident, or if the clock cannot be read, the DDC panel shall not restart and systems shall remain in the failure mode until the necessary repairs are made. If the database and applications programs are resident, the DDC panel shall resume operation after an adjustable time delay of from 0 to 600 seconds. The startup sequence for each DDC panel shall include a unique time delay setting when system operation is initiated.

d. DDC Panel Operating Mode

Each DDC panel shall control and monitor all functions as specified independent of communications with any other source. This software shall perform all DDC panel functions and DDC panel resident applications programs as specified using data obtained from I/O functions and based upon the DDC panel real time clock function.

The DDC panel software shall execute commands after performing constraints checks in the DDC panel.

e. DDC Panel Failure Mode

Upon failure for any reason, the system shall perform an orderly shutdown and force all DDC panel outputs to a predetermined state, consistent with the failure modes defined in the I/O summary tables and the associated controlled devices.

f. DDC Panel Functions

Provide software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within the DDC panel.

(1) Scanning of inputs.

(2) Control of outputs.

(3) Store alarms for reporting when requested.

(4) Maintain real time.

(5) Execute DDC panel resident applications programs.

(6) Averaging or filtering of each analog input.

(7) Constraints checks (prior to command issuance).

(8) DDC panel diagnostics.

(9) DDC panel portable tester operation as specified.

g. Analog Monitoring

The DDC panel shall measure all analog values. It shall be capable of transmitting all analog values for display. An analog change in value is defined as a change exceeding a preset differential value as specified. All displays and reports shall express analog values in proper engineering units with polarity sign. The system shall accommodate up to 255 different sets of engineering unit conversions. Each engineering unit conversion shall include range, span, and conversion equation.

h. Logic (Virtual) Points

Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. This value shall be created by calculating it from any combination of digital and analog points, or other data. Logic points shall be analog or digital points having all the properties of real points, including alarms, without the associated hardware. Logic points shall be defined or calculated and entered into the database by the Contractor as required. The calculated analog point shall have point identification in the same format as any other analog point. The calculated point shall be used in any program where the real value is not obtainable directly. Calculated point values shall be current for use by the system within 30 seconds of the time any input value change and shall include:

(1) Control loop setpoints.

(2) Control loop gain constants.

(3) Control loop integral constants.

(4) Summer/winter operation.

(5) Real time.

(6) Scheduled on/off times.

(7) Equipment run-time targets.

(8) Calculated point values.

i. I/O Point Database

(1) I/O Point Definition

Each I/O point shall be defined in a database in the DDC panel. The definition shall include all physical parameters and constraints associated with each point.

(2) Parameter Definition

Each I/O point shall be defined and entered into the database by the Contractor, including as applicable:

(a) Name.

(b) Device or sensor type (i.e., sensor, control, motors).

(c) Point identifications number.

(d) Area.

(e) Sensor range.

(f) Controller range.

(g) Sensor span.

(h) Controller span.

(i) Engineering units conversion (scale factor).

(j) High and low reasonableness value (analog).

(k) High and low alarm limit (analog).

(l) High and low alarm limit differential (return to normal).

(m) Analog change differential (for reporting).

(n) High accumulator limit (pulse).

(o) Status description (digital inputs).

j. Alarm Processing

Each DDC panel shall have alarm processing software for digital, analog, and pulse accumulator alarms for all input and virtual points connected to that DDC panel.

(1) Digital Alarms Definition

Digital alarms are those abnormal conditions indicated by digital inputs as specified in the I/O Summary Tables and elsewhere.

(2) Analog Alarms Definition

Analog alarms are those conditions higher or lower than a defined value, as measured by an analog input as specified in the I/O Summary Tables and elsewhere. Analog readings shall be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each analog point in the system. All analog alarm limits shall be stored in the DDC panel database. Each analog alarm limit shall have an associated unique limit differential specifying the amount by which a variable must return into the proper operating range before being declared as a return-to-normal state. All limits and differentials shall be entered on-line by the operator in limits or the measured variable, without interruption or loss of monitoring of the point concerned.

(3) Pulse Accumulator Alarms Definition

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or pulse accumulator inputs rates that are outside defined limits as specified in the I/O Summary Tables and elsewhere. Pulse accumulator totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each pulse accumulator point in the system. Limits shall be stored in the DDC panel database.

k. Constraints

(1) Equipment Constraints Definitions

Each control point in the database shall have DDC panel resident constraints defined and entered by the Contractor, including as applicable:

(a) Minimum off time.

(b) Minimum on time.

(c) High limit (value in engineering units).

(d) Low limit (value in engineering units).

(2) Constraints Checks

All control devices connected to the system shall have the DDC panel memory resident constraints checked before each command is issued to insure that no equipment damage will result from improper operation. Each command shall be executed by the DDC panel only after all constraints checks have been passed. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each analog input. Values outside the reasonableness limits shall be rejected and an alarm generated. Status changes and analog point values shall be reported upon request, such as for reports, and applications programs. Each individual point shall be capable of being selectively disabled by the operator. Disabling a point shall prohibit monitoring and automatic control of that point.

l. DDC Panel Diagnostics

Each DDC panel shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory. Diagnostic software shall be provided for use in the portable tester. The software shall display messages in plain language to inform the tester's operator of diagnosed problems.

m. Summer/Winter Operation Monitoring

The system shall provide software to change the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system where such a change from summer to winter and vice versa is meaningful. The software shall provide commands to applications programs to coordinate summer or winter operation.

n. Control Sequences and Control Loops

Operator commands shall be used to create and execute control sequences and control loops for automated control of equipment based on operational parameters including times and events, defined in the database. Through the command entry device, the system shall prompt the operator for information necessary to create, modify, list, and delete control sequences and Proportional plus Integral plus Derivative (PID) control loops. The system shall prompt the operator for confirmation that the control sequence and control loop addition/modification/deletion is correct, prior to placing it in operation. All mathematic functions required shall be available for use in creating the control sequences and control loops. Sufficient spare memory shall be provided to allow four control sequences and four control loops in addition to those necessary to implement the requirements specified for each DDC panel. Each control sequence shall accommodate up to eight terms or devices.

(1) Control Functions

The DDC panel shall provide the following control functions:

(a) PID Control - The system shall provide for PID control. The control algorithm intended for use shall be submitted for approval with a full explanation of its functions and limitations. A determination shall be made of the antiwindup limit for the DDC panel software (for example, an antiwindup limit of plus/minus one half of the actuator range).

(b) Two Position Control - This function shall provide control for two state device control by comparing a setpoint against a process variable and an established deadband.

(c) Floating Point Control - The function shall exercise control when an error signal exceeds a selected deadband, and shall maintain control until the error is within the deadband limits.

(d) Signal Selection - This function shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control. The function shall include the ability to cascade analog values so that large numbers of inputs up to a maximum of 20 can be reduced to one or two outputs.

(e) Reset Function - This function shall develop an analog output based on up to two analog inputs and one operator specified reset schedule.

(f) Self Tuning - The controller shall provide self tuning operation to proportional, integral and derivative modes of control and shall modify the mode constants as required.

(2) DDC Panel Resident Applications Software

Provide applications software as specified and required to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the systems connected to the DDC system. All applications software shall be resident and executing in the DDC panel, and shall be coordinated to insure that no conflicts or contentions remain unresolved. The following software shall be provided in addition to that required elsewhere:

(3) Optimum Start/Stop Program

HVAC equipment which is required to be started and stopped based on a time schedule shall be subject to this program. The program shall take into account the thermal characteristics of the structure, indoor and outdoor air conditions using prediction software to determine the minimum time of HVAC system operation needed to satisfy space environmental requirements at the start of the occupied cycle, and determine the earliest time for stopping equipment at the day's end without allowing the space environmental conditions to drift out of the range specified for the occupied cycle before the start of the unoccupied cycle.

## 2.6 TRANSIENT PROTECTION

The communications circuitry and input/output circuitry, of the SDC's and ADC's, shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer's catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the FMCS controller. Protection shall be provided for the individual communications and input/output terminations for each FMCS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

## 2.7 WIRE AND CABLE

Provide all wire and cable.

### 2.7.1 Control Wiring

#### 2.7.1.1 Digital Functions

Control wiring for digital functions shall be 18 AWG minimum with 600-volt insulation. Multiconductor wire shall have an outer jacket of polyvinyl chloride (PVC).

#### 2.7.1.2 Analog Functions

Control wiring for analog functions shall be 18 AWG minimum with 600-volt insulation, twisted and shielded, two-, three-, or four-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

### 2.7.2 Sensor Wiring

Sensor wiring shall be 20 AWG minimum twisted and shielded, two-, three-, or four-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

### 2.7.3 Class 2 Low Energy Conductors

The conductor sizes specified for digital and analog functions shall take precedence over any requirements for Class 2 low energy remote-controlled and signal-circuit conductors specified elsewhere.

# PART 3 EXECUTION

## 3.1 GENERAL INSTALLATION CRITERIA

### 3.1.1 HVAC Control System

The HVAC control system shall be completely installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control-system installation shall provide clearance for control-system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control-system devices. The control-system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

### 3.1.2 Software Installation

Load all software required for an operational system, including databases (to include databases for all points specified and shown), operational parameters, and system, command, and applications software. Within 30 days of Government formally accepting installed system provided under this Contract, the Contractor shall provide original and backup copies of source (excluding the general purpose operating systems and utility programs furnished by the computer manufacturers and the non-job specific proprietary code furnished by the system manufacturer) and object modules for all software, on each type of media utilized.

### 3.1.3 Device-Mounting Criteria

Devices mounted in or on piping or ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping and ductwork shall be provided with all required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

#### 3.1.4 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways in exposed areas. Run plenum cable in accessible non-exposed areas. Wiring shall be installed without splices between control devices and DDC panels. Instrumentation grounding shall be installed as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Cables and conductors wires shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415, ELECTRICAL WORK, INTERIOR. Wiring shall be color coded according to wiring application (i.e.; one color for LAN, one color for sensor wiring, etc). Other electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

### 3.2 CONTROL-SYSTEM INSTALLATION

#### 3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

#### 3.2.2 Smoke Detectors

Smoke detectors shall be installed. Wiring to the fire alarm system shall be by the fire alarm contractor. Coordinate with the fire alarm contractor.

#### 3.2.3 Room-Instrument Mounting

Room instruments shall be mounted so that their sensing elements are 5 feet above the finished floor unless otherwise shown. Temperature setpoint device shall be recess mounted.

#### 3.2.4 Freezestats

For each 20 square feet of coil-face area, or fraction thereof, a freezestat shall be provided to sense the temperature at the location shown. Manual reset freezestats shall be installed in approved, accessible locations where they can be reset easily. The freezestat sensing element shall be installed in a serpentine pattern.

### 3.2.5 Averaging-Temperature Sensing Elements

Sensing elements shall have a total-element minimum length equal to 1 linear foot per square foot of duct cross-sectional area.

### 3.2.6 Foundations and Housekeeping Pads

Foundations and housekeeping pads shall be provided for the HVAC control-system air compressors.

### 3.2.7 Paragraph Not Used

### 3.2.8 Duct Static-Pressure Sensing Elements and Transmitters

The duct static-pressure sensing element and transmitter sensing point shall be located approximately two-thirds of the distance from the supply fan to the end of the duct with the greatest pressure drop  Install sensors in a straight section of duct positioned such that there are 8 diameters of upstream and 2 diameters downstream with no turns in the duct.

### 3.2.9 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers.  Gauges for steam service shall have pigtail fittings with cock.  Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

## 3.3 CONTROL SEQUENCES OF OPERATION

See drawings.

## 3.4 TRAINING

Conduct a 4 hour training class for operating staff members designated by the Contracting Officer in the maintenance and operation of the system specified, including all specified hardware and software. For guidance in planning the required instruction, the Contractor shall assume that the attendees will have a high school education or equivalent, and are familiar with HVAC systems.  Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.  No training of any type will be scheduled until training manuals and O&M manuals have been approved by the Government.

-- End of Section --

SECTION 15995

# COMMISSIONING OF HVAC SYSTEMS
**04/01**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Commissioning Team.

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

Test Procedures.

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

Test Schedule; G, RE.

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

SD-06 Test Reports

Test Reports; G, RE.

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

### 1.2 SEQUENCING AND SCHEDULING

The work described in this Section shall begin only after all work required in related Sections, including Section 1595{AM#0001}__2 DIRECT DIGITAL CONTROL FOR HVAC and Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved.Seismic details shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

## PART 2 PRODUCTS (Not Applicable)

## PART 3 EXECUTION

### 3.1 COMMISSIONING TEAM AND CHECKLISTS

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

| Designation | Function |
|---|---|
| Q | Contractor's Chief Quality Control Representative |
| M | Contractor's Mechanical Representative |
| E | Contractor's Electrical Representative |
| T | Contractor's Testing, Adjusting, and Balancing Representative |
| C | Contractor's Controls Representative |
| D | Design Agent's Representative |
| O | Contracting Officer's Representative |
| U | Using Agency's Representative |

Each checklist shown in appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

### 3.2 TESTS

The pre-commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members.

3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the checklists in Appendix A. Deficiencies discovered during these checks shall be corrected and retested in accordance with the applicable contract requirements.

3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

APPENDIX A

PRE-COMMISSIONING CHECKLISTS

Pre-commissioning checklist - Piping

For All Piping System

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Installation | | | | | | | | |
| a. Piping complete. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| b. As-built shop drawings submitted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| c. Piping flushed and cleaned. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| d. Strainers cleaned. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| e. Valves installed as required. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| f. Piping insulated as required. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| g. Thermometers and gauges installed as required. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| h. Verify operation of valves. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| i. Air vents installed as specified. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| j. Flexible connectors installed as specified | __ | ___ | X | X | X | ___ | ___ | ___ |
| k. Verify that piping has been labeled and valves identified as specified. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. Hydrostatic test complete. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| b. TAB operation complete. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Ductwork

For Air Handler: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Installation | | | | | | | | |
| a. Ductwork complete. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| b. As-built shop drawings submitted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| c. Ductwork leak test complete. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

NOTE: The first bracketed item d will be used for Army projects, the second for Air Force projects.

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| d. Fire dampers, and access doors installed as required. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| e. Ductwork insulated as required. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| f. Thermometers and gauges installed as required. | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| g. Verify open/closed status of dampers. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| h. Verify smoke dampers operation. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| i. Flexible connectors installed as specified | __ | ___ | X | ___ | X | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. TAB operation complete. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Pre-commissioning Checklist - Multizone Air Handling Unit

For Air Handling Unit: AHU-3, 4

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| **Installation** | | | | | | | | |
| a. Vibration isolation devices installed as specified. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| b. Inspection and access doors are operable and sealed. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| c. Casing undamaged. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Insulation undamaged. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| e. Condensate drainage is unobstructed. (Visually verify pan drains completely by pouring a cup of water into drain pan.) | ___ | ___ | X | X | X | ___ | ___ | ___ |
| f. Fan belt adjusted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| g. Manufacturer's required maintenance clearance provided. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| **Electrical** | | | | | | | | |
| a. Power available to unit disconnect. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| b. Power available to unit control panel. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| c. Proper motor rotation verified. | ___ | ___ | ___ | ___ | X | ___ | ___ | ___ |
| d. Verify that power disconnect is located within sight of the unit it controls. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| **Coils** | | | | | | | | |
| a. Chilled water piping properly connected. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| b. Refrigerant piping pressure tested. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| c. Hot water piping properly connected. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Steam and condensate piping pressure tested. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| e. Air vents installed on water coils with shutoff valves as specified. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| f. Any damage to coil fins has been repaired | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Pre-commissioning Checklist - Multizone Air Handling Unit

For Air Handling Unit: AHU-3, 4

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Controls | | | | | | | | |
| a. Control valves/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Control valves/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. O.A. dampers/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| d. O.A. dampers/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| e. Zone dampers/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| f. Zone dampers/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. Construction filters removed and replaced. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| b. TAB report submitted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| c. TAB results within +10%/-0% of L/s shown on drawings | | | | | | | | |
| d. TAB results for outside air intake within +10%/-0% of L/s shown on drawings. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU-1, AHU-2

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| **Installation** | | | | | | | | |
| a. Vibration isolation devices installed. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| b. Inspection and access doors are operable and sealed. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| c. Casing undamaged. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Insulation undamaged. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| e. Condensate drainage is unobstructed. (Visually verify drainage by pouring a cup of water into drain pan.) | ___ | ___ | X | X | X | ___ | ___ | ___ |
| f. Fan belt adjusted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| g. Manufacturer's required maintenance clearance provided. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| **Electrical** | | | | | | | | |
| a. Power available to unit disconnect. | ___ | ___ | ___ | X | X | ___ | ___ | ___ |
| b. Power available to unit control panel. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| c. Proper motor rotation verified. | ___ | ___ | ___ | ___ | X | ___ | ___ | ___ |
| d. Verify that power disconnect is located within sight of the unit it controls. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| **Coils** | | | | | | | | |
| a. Chilled water piping properly connected. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| b. Chilled water piping pressure tested. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| c. Hot water piping properly connected. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Hot water piping pressure tested. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| e. Air vents installed on water coils as specified. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| f. Any damage to coil fins has been repaired. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Controls

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU-1, AHU-2

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| a. Control valves/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Control valves/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. Dampers/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| d. Dampers/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| e. Verify proper location, installation and calibration of duct static pressure sensor. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| f. Fan air volume controller operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| g. Air handler controls system operational. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. Construction filters removed and replaced. | __ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. TAB report submitted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| c. TAB results within +10%/-0% of L/s shown on drawings | | | | | | | | |
| d. TAB results for outside air intake within +10%/-0% of both the minimum and maximum L/s shown on drawings. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Pre-commissioning Checklist - VAV Terminal

For VAV Terminal: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Installation | | | | | | | | |
| a. VAV terminal in place. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| b. VAV terminal ducted. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| c. VAV terminal connected to controls. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| d. Reheat coil connected to hot water pipe. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| f. Manufacturer's required maintenance clearance provided. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| Controls | | | | | | | | |
| a. Cooling only VAV terminal controls set. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| b. Cooling only VAV controls verified. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| c. Reheat VAV terminal controls set. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| d. Reheat terminal/coil controls verified. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. Verify terminal maximum air flow set. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Verify terminal minimum air flow set. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. TAB operation complete. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Pre-commissioning Checklist - DX Air Cooled Condensing Unit

For Condensing Unit: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Installation | ___ | ___ | X | X | X | ___ | ___ | ___ |
| b. Refrigerant pipe leak tested. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| c. Refrigerant pipe evacuated and charged in accordance with manufacturer's instructions. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Check condenser fans for proper rotation. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| e. Any damage to coil fins has been repaired. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| f. Manufacturer's required maintenance/ operational clearance provided. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| Electrical | | | | | | | | |
| a. Power available to unit disconnect. | ___ | ___ | ___ | X | X | ___ | ___ | ___ |
| b. Power available to unit control panel. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| c. Verify that power disconnect is located within sight of the unit it controls | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| Controls | | | | | | | | |
| a. Unit safety/protection devices tested. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| b. Control system and interlocks installed. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| c. Control system and interlocks operational. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Pumps

For Pump: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| **Installation** | | | | | | | | |
| a. Pumps grouted in place. | | | X | X | X | | | |
| b. Pump vibration isolation devices functional. | | | X | X | X | | | |
| c. Pump/motor coupling alignment verified. | | | X | X | X | | | |
| d. Piping system installed. | | | X | X | X | | | |
| e. Piping system pressure tested. | | | X | X | X | | | |
| f. Pump not leaking. | | | X | X | X | | | |
| g. Field assembled couplings aligned to meet manufacturer's prescribed tolerances. | | | X | X | X | | | |
| **Electrical** | | | | | | | | |
| a. Power available to pump disconnect. | | | | X | X | | | |
| b. Pump rotation verified. | | | | X | X | | | |
| c. Control system interlocks functional. | | | | X | | | | |
| d. Verify that power disconnect is located within sight of the unit it controls. | | | | X | | | | |
| **Testing, Adjusting, and Balancing (TAB)** | | | | | | | | |
| a. Pressure/temperature gauges installed. | | | X | | X | | | |
| b. Piping system cleaned. | | | X | X | X | | | |
| c. Chemical water treatment complete. | | | X | X | X | | | |
| d. Water balance complete. | | | X | | X | | | |
| e. Water balance with design maximum flow. | | | X | | X | | | |
| f. TAB Report submitted. | | | X | | X | | | |

Pre-commissioning Checklist - Packaged Air Cooled Chiller

For Chiller: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| **Installation** | | | | | | | | |
| a. Chiller properly piped. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Chilled water pipe leak tested. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| c. Verify that refrigerant used complies with specified requirements. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Any damage to coil fins has been repaired. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| e. Manufacturer's required maintenance clearance provided. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| **Electrical** | | | | | | | | |
| a. Power available to unit disconnect. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| b. Power available to unit control panel. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| c. Separate power is supplied to electric heating tape. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| d. Verify that power disconnect is located within sight of the unit it controls. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| **Controls** | | | | | | | | |
| a. Factory startup and checkout complete. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| b. Chiller safety/protection devices tested. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| c. Chilled water flow switch installed. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| d. Chilled water flow switch tested. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| e. Chilled water pump interlock installed. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| f. Chilled water pump interlock tested. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Hot Water Boiler

For Boiler: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| **Installation** | | | | | | | | |
| a. Boiler flue installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Boiler hot water piping installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. Boiler hot water piping tested. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| d. Boiler makeup water piping installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| g. Boiler gas piping installed. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| h. Boiler gas piping tested. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| i. Manufacturer's required maintenance clearance provided. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| **Startup** | | | | | | | | |
| a. Boiler system cleaned and filled with treated water. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Boiler safety/protection devices, including high temperature burner shut-off, low water cutoff, flame failure, pre and post purge, have been tested. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| c. Verify that PRV rating conforms to boiler rating. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| d. Boiler water treatment system functional. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| e. Boiler startup and checkout complete. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| f. Combustion efficiency demonstrated. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| **Electrical** | | | | | | | | |
| a. Verify that power disconnect is located within sight of the unit served. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| **Controls** | | | | | | | | |
| a. Hot water pump interlock installed. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| b. Hot water pump interlock tested. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Hot Water Boiler

For Boiler: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| c. Hot water heating system balanced. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| d. Hot water heating controls operational. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Unit Heater

For Unit Heater: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Installation | | | | | | | | |
| a. Hot water piping properly connected. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Hot water piping pressure tested. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. Air vent installed on hot water coil with shutoff valve as specified. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Any damage to coil fins has been repaired. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| e. Manufacturer's required maintenance/ operational clearance provided. | ___ | ___ | X | X | X | ___ | ___ | ___ |
| Electrical | | | | | | | | |
| a. Power available to unit disconnect. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| b. Proper motor rotation verified. | ___ | ___ | ___ | X | X | ___ | ___ | ___ |
| c. Verify that power disconnect is located within sight of the unit it controls. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| d. Power available to electric heating coil. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| Controls | | | | | | | | |
| a. Control valves properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Control valves operable. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| c. Verify proper location and installation of thermostat. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. TAB Report submitted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Pre-commissioning Checklist - Exhaust Fan

For Exhaust Fan:

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Installation | | | | | | | | |
| a. Fan belt adjusted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| Electrical | | | | | | | | |
| a. Power available to fan disconnect. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| b. Proper motor rotation verified. | ___ | ___ | ___ | ___ | X | ___ | ___ | ___ |
| c. Verify that power disconnect is located within sight of the unit it controls. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| Controls | | | | | | | | |
| a. Control interlocks properly installed. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| b. Control interlocks operable. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| c. Dampers/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| d. Dampers/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| e. Verify proper location and installation of thermostat. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. TAB results +10%/-0% to L/s shown on drawings | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| b. TAB Report submitted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Pre-commissioning Checklist - HVAC System Controls

For HVAC System: All

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| Installation | | | | | | | | |
| a. As-built shop drawings submitted. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| b. Layout of control panel matches drawings. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| c. Framed instructions mounted in or near control panel. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| d. Components properly labeled (on inside and outside of panel). | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| e. Control components piped and/or wired to each labeled terminal strip. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| f. EMCS connection made to each labeled terminal strip as shown. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| g. Control wiring and tubing labeled at all terminations, splices, and junctions. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |
| h. Shielded wiring used on electronic sensors. | __ | __ | X | X | ___ | ___ | ___ | ___ |
| Main Power and Control Air | | | | | | | | |
| a. 110 volt AC power available to panel. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| Testing, Commissioning, and Balancing | | | | | | | | |
| a. Testing, Commissioning, and Balancing Report submitted. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: AHU-5

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| **Installation** | | | | | | | | |
| a. Vibration isolation devices installed. | | | X | X | X | | | |
| b. Inspection and access doors are operable and sealed. | | | X | | X | | | |
| c. Casing undamaged. | | | X | X | X | | | |
| d. Insulation undamaged. | | | X | X | X | | | |
| e. Condensate drainage is unobstructed. | | | X | X | X | | | |
| f. Fan belt adjusted. | | | X | | X | | | |
| g. Any damage to coil fins has been repaired. | | | X | | X | | | |
| h. Manufacturer's required maintenance clearance provided. | | | X | X | X | | | |
| **Electrical** | | | | | | | | |
| a. Power available to unit disconnect. | | | | X | X | | | |
| b. Power available to unit control panel. | | | | X | | | | |
| c. Proper motor rotation verified. | | | | | X | | | |
| d. Verify that power disconnect is located within sight of the unit it controls. | | | | X | | | | |
| **Coils** | | | | | | | | |
| a. Chilled water piping properly connected. | | | X | | | | | |
| b. Chilled water piping pressure tested. | | | X | X | X | | | |
| c. Hot water piping properly connected. | | | X | | | | | |
| d. Hot water piping pressure tested. | | | X | X | | | | |
| e. Air vents installed on water coils as specified. | | | X | X | X | | | |
| f. Any damage to coil fins has been repaired. | | | X | | X | | | |

Controls

Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: AHU-5

| Checklist Item | Q | M | E | T | C | D | O | U |
|---|---|---|---|---|---|---|---|---|
| a. Control valves/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Control valves/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. Dampers/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| d. Dampers/actuators operable. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| e. Verify proper location and installation of thermostat. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB) | | | | | | | | |
| a. Construction filters removed and replaced. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| b. TAB results +10%/-0% L/s shown on drawings. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| c. TAB Report submitted. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

# APPENDIX B

# FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Pumps

For Pump: All

Prior to performing this checklist, ensure that for closed loop systems, system is pressurized and the make-up water system is operational or, for open loop systems, that the sumps are filled to the proper level.

1. Activate pump start using control system commands (all possible combination, on/auto, etc.). ON__________ AUTO__________ OFF__________

a. Verify pressure drop across strainer:

Strainer inlet pressure __________ kPa (_____ psig)
Strainer outlet pressure _________ kPa (_____ psig)

b. Verify pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, pump design conditions, and pump manufacturer's performance.

| | DESIGN | SYSTEM TEST | ACTUAL |
|---|---|---|---|
| Pump inlet pressure (kPa gauge) | _________ | __________ | __________ |
| Pump outlet pressure (kPa gauge) | _________ | __________ | __________ |

c. Operate pump at shutoff and at 100 percent of designed flow when all components are in full flow. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

| | SHUTOFF | 100 percent |
|---|---|---|
| Pump inlet pressure (kPa gauge) | __________ | __________ |
| Pump outlet pressure | __________ | __________ |
| Pump flow rate (L/s) | __________ | __________ |

d. Operate pump at shutoff and at minimum flow or when all components are in full by-pass. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

| | SHUTOFF | 100 percent |
|---|---|---|
| Pump inlet pressure (kPa gauge) | __________ | __________ |
| Pump outlet pressure | __________ | __________ |
| Pump flow rate (L/s) | __________ | __________ |

2. Verify motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions.

a. Full flow:

| | PHASE 1 | PHASE 2 | PHASE 3 |
|---|---|---|---|
| Amperage | __________ | __________ | __________ |
| Voltage | | __________ | __________ |

Functional Performance Test Checklist - Pumps

For Pump: All

| | | | |
|---|---|---|---|
| Voltage | ______________________ | | |
| Voltage to ground | ________ | ________ | ________ |

b. Minimum flow:

| | PHASE 1 | PHASE 2 | PHASE 3 |
|---|---|---|---|
| Amperage | ________ | ________ | ________ |
| Voltage | ________ | ________ | |
| Voltage | ______________________ | | |
| Voltage to ground | ________ | ________ | ________ |

3. Unusual vibration, noise, etc.

_______________________________________________________________

_______________________________________________________________

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

| | Signature and Date |
|---|---|
| Contractor's Chief Quality Control Representative | ________________________ |
| Contractor's Mechanical Representative | ________________________ |
| Contractor's Electrical Representative | ________________________ |
| Contractor's Testing, Adjusting and Balancing Representative | ________________________ |
| Contractor's Controls Representative | ________________________ |
| Contracting Officer's Representative | ________________________ |
| Using Agency's Representative | ________________________ |

Functional Performance Test Checklist - VAV Terminals

The Contracting officer will select VAV terminals to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent.

1. Functional Performance Test: Contractor shall demonstrate operation of selected VAV boxes as per specifications including the following:

a. Cooling only VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Maximum flow as scheduled
Minimum flow as scheduled

(2) Check damper maximum/minimum flow settings.

Maximum flow setting as scheduled
Minimum flow setting as scheduled

b. Cooling with reheat VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 3 degrees C above ambient and measure maximum air flow. Turn thermostat to 3 degrees C below ambient and measure minimum air flow.

Maximum flow as scheduled
Minimum flow as scheduled

(2) Check damper maximum/minimum flow settings.

Maximum flow setting as scheduled
Minimum flow setting as scheduled

Reheat coil operation range (full open to full closed) ____________________

c. Fan powered VAV boxes:

(1) Verify VAV box response to sensor call for heating via set point adjustment. Changes to be cooling setpoint to heating set point and return to cooling set point. __________ Verify cooling damper closes to minimum position, blower fan energizes according to sequence of operation, and upon further drop in space temperature, heating coil activation and deactivation. __________

(2) Check primary air damper maximum/minimum flow settings.

Functional Performance Test Checklist - VAV Terminals
Maximum flow setting as scheduled
Minimum flow setting as scheduled

(3) Check blower fan flow. as scheduled

(4) Verify free operation of fan backdraft damper (insure no primary air is being discharged through the recirculated air register). ____________________

(5) Verify that no recirculated air is being induced when box is in full cooling. ____________________

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

| | Signature and Date |
|---|---|
| Contractor's Chief Quality Control Representative | ____________________ |
| Contractor's Mechanical Representative | ____________________ |
| Contractor's Electrical Representative | ____________________ |
| Contractor's Testing, Adjusting and Balancing Representative | ____________________ |
| Contractor's Controls Representative | ____________________ |
| Contracting Officer's Representative | ____________________ |
| Using Agency's Representative | ____________________ |

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU-1, AHU-2

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply and return fans operating mode is initiated:

(1) All dampers in normal position . ____________________

(2) All valves in normal position. ____________________

(3) System safeties allow start if safety conditions are met. _____

(4) VAV fan controller shall "soft-start" fan. ____________________

(5) Modulate all VAV boxes to minimum air flow and verify that the static pressure does not exceed the design static pressure Class shown. ____________________

b. Occupied mode of operation.

(1) Outside air damper at minimum position. ____________________

(2) Return air damper open. ____________________

(3) Relief air damper [at minimum position] [closed]. ____________

(4) Chilled water control valve modulating to maintain leaving air temperature set point. ____________________

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point. ____________________

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. ____________________

(2) Relief air damper modulates with outside air damper according to sequence of operation. ____________________

(3) Chilled water control valve modulating to maintain leaving air temperature set point. ____________________

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU-1, AHU-2

(4) Hot water control valve modulating to maintain leaving air temperature set point. ____________________

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point. ____________________

d. Unoccupied mode of operation

(1) All dampers in normal position. ____________________

(2) Verify low limit space temperature is maintained as specified in sequence of operation. ____________________

e. The following shall be verified when the supply and return fans off mode is initiated:

(1) All dampers in normal position. ____________________

(2) All valves in normal position. ____________________

(3) Fan de-energizes. ____________________

f. Verify the chilled water coil control valve operation by setting all VAV's to maximum and minimum cooling.

| | Max cooling | Min cooling |
|---|---|---|
| Supply air volume (_____ L/s) | ___________ | ___________ |
| Supply air temp. (_____ degrees C) | ___________ | ___________ |

g. Verify safety shut down initiated by smoke detectors. ____________

h. Verify safety shut down initiated by low temperature protection thermostat. ____________________

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

| | Signature and Date |
|---|---|
| Contractor's Chief Quality Control Representative | ____________________ |
| Contractor's Mechanical Representative | ____________________ |
| Contractor's Electrical Representative | ____________________ |

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU-1, AHU-2

Contractor's Testing, Adjusting and Balancing Representative ______________________________

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AHU-1, AHU-2

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: AHU-5

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply and return fans operating mode is initiated:

(1) All dampers in normal position. ______________________________

(2) All valves in normal position. ______________________________

(3) System safeties allow start if safety conditions are met. _____

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. ______________________

(2) Return air damper open. ______________________________________

(3) Relief air damper at minimum position. ____________

(4) Chilled water control valve modulating to maintain space cooling temperature set point. _____________________________________________

(5) Hot water control valve modulating to maintain space heating temperature set point input from outside air temperature controller. ________

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. _________________________________________________________________

(2) Relief air damper modulates with outside air damper according to sequence of operation. ________________________________________________

(3) Chilled water control valve modulating to maintain space cooling temperature set point. _____________________________________________

d. Unoccupied mode of operation

(1) All dampers in normal position. ______________________________

(2) Verify low limit space temperature is maintained as specified in sequence of operation. ___________________________________________________

e. The following shall be verified when the supply and return fans off

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: AHU-5
mode is initiated:

(1) All dampers in normal position. ______________________________

(2) All valves in normal position. _______________________________

(3) Fan de-energizes. ___________________________________________

f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point. ____________________________________________

g. Verify safety shut down initiated by smoke detectors. _____________

h. Verify safety shut down initiated by low temperature protection thermostat. ______________________________________________________________

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

_____________________________

Contractor's Mechanical Representative _____________________________

Contractor's Electrical Representative _____________________________

Contractor's Testing, Adjusting and Balancing Representative

_____________________________

Contractor's Controls Representative _____________________________

Contracting Officer's Representative _____________________________

Using Agency's Representative _____________________________

Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: AHU-3, 4

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply and return fans operating mode is initiated:

(1) All dampers in normal position. ________________________________

(2) All valves in normal position. _________________________________

(3) System safeties allow start if safety conditions are met. _____

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. _______________________

(2) Return air damper open. _______________________________________

(3) Relief air damper at minimum position. _____________

(4) Chilled water control valve modulating to maintain cold deck supply air temperature set point. _____________________________________________

(5) Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller.
______________________________________________________________________________

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulates to maintain mixed air temperature set point. _____________________________________________________________

(2) Relief air damper modulates with outside air damper according to sequence of operation. ______________________________________________________

(3) Chilled water control valve modulating to maintain cold deck supply air temperature set point. _____________________________________________

(4) Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller.
______________________________________________________________________________

d. Unoccupied mode of operation

(1) All dampers in normal position. ______________________________

Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: AHU-3, 4

(2) Verify low limit space temperature is maintained as specified in sequence of operation. ____________________________________________

e. The following shall be verified when the supply and return fans off mode is initiated:

(1) All dampers in normal position. ____________________________

(2) All valves in normal position. _____________________________

(3) Fan de-energizes. ___________________________________________

f. Verify zone damper operation by varying zone thermostat set points from cooling set point to heating set point and returning to cooling set point. ________________________________________________________________

g. Verify safety shut down initiated by smoke detectors. ____________

h. Verify safety shut down initiated by low temperature protection thermostat. ___________________________________________________________

i. Index room thermostats to full cooling then to full heating. Measure and record cold deck, hot deck, and supply air temperatures and determine damper leakage for a minimum of 2 zones.

Cold deck temperature __________ degrees C (_____ degrees F)
Hot deck temperature __________ degrees C (_____ degrees F)

Zone _______
Cooling temperature _______ degrees C (_____ degrees F)
Heating temperature _______ degrees C (_____ degrees F)
Damper leakage cooling ____ degrees C (_____ degrees F)
Damper leakage heating ____ degrees C (_____ degrees F)

Zone _______
Cooling temperature _______ degrees C (_____ degrees F)
Heating temperature _______ degrees C (_____ degrees F)
Damper leakage cooling ____ degrees C (_____ degrees F)
Damper leakage heating ____ degrees C (_____ degrees F)

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: AHU-3, 4

Contractor's Mechanical Representative ______________________________

Contractor's Electrical Representative ______________________________

Contractor's Testing, Adjusting and Balancing Representative ______________________________

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: All

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows.

a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof-of-flow switch operation. ____________________

b. Verify control system energizes chiller start sequence. ___________

c. Verify chiller senses chilled water temperature above set point and control system activates chiller start. ________________________________

d. Verify functioning of "soft start" sequence. _____________________

e. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. ___________________________________________________

f. Restart air handling equipment one minute after chiller shut down. Verify chiller restart sequence. _________________________________________

2. Verify chiller inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions, and chiller manufacturer's performance data.

| | DESIGN | SYSTEM TEST | ACTUAL |
|---|---|---|---|
| Chiller inlet pressure (kPa gauge) | __________ | __________ | __________ |
| Chiller outlet pressure (kPa gauge) | __________ | __________ | __________ |

3. Verify chiller amperage each phase and voltage phase-to-phase and phase-to-ground.

| | PHASE 1 | PHASE 2 | PHASE 3 |
|---|---|---|---|
| Amperage | __________ | __________ | __________ |
| Voltage | __________ | __________ | |
| Voltage | ______________________ | | |
| Voltage to ground | __________ | __________ | __________ |

4. Record the following information:

Ambient dry bulb temperature ___________ degrees C
Ambient wet bulb temperature ___________ degrees C
Entering chilled water temperature _____ degrees C
Leaving chilled water temperature ______ degrees C

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: All

5. Unusual vibration, noise, etc.

__________________________________________________________________________

__________________________________________________________________________

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

| | Signature and Date |
|---|---|
| Contractor's Chief Quality Control Representative | _____________________________ |
| Contractor's Mechanical Representative | _____________________________ |
| Contractor's Electrical Representative | _____________________________ |
| Contractor's Testing, Adjusting and Balancing Representative | _____________________________ |
| Contractor's Controls Representative | _____________________________ |
| Contracting Officer's Representative | _____________________________ |
| Using Agency's Representative | _____________________________ |

Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: All

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

a. Start air handling unit. Verify control system energizes condensing unit start sequence. ____________________

b. Shut off air handling equipment to verify condensing unit de-energizes. ____________________

c. Restart air handling equipment one minute after condensing unit shut down. Verify condensing unit restart sequence. ____________________

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

| | PHASE 1 | PHASE 2 | PHASE 3 |
|---|---|---|---|
| Amperage | ________ | ________ | ________ |
| Voltage | ________ | ________ | |
| Voltage | ________________ | | |
| Voltage to ground | ________ | ________ | ________ |

3. Record the following information:

| | | |
|---|---|---|
| Ambient dry bulb temperature | ________ | degrees C |
| Ambient wet bulb temperature | ________ | degrees C |
| Suction pressure | ________ | kPa gauge |
| Discharge pressure | ________ | kPa gauge |

4. Unusual vibration, noise, etc.

____________________________________________

____________________________________________

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative ____________________

Contractor's Mechanical Representative ____________________

Contractor's Electrical Representative Representative ____________________

Contractor's Testing, Adjusting and Balancing ____________________

Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: All

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

Functional Performance Test Checklist - Hot Water Boiler

For Boiler: All

1. Functional Performance Test: Contractor shall demonstrate operation of hot water system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start hot water pump and establish hot water flow. Verify boiler hot water proof-of-flow switch operation. ______________________________

b. Verify control system energizes boiler start sequence. ___________

c. Verify boiler senses hot water temperature below set point and control system activates boiler start. ___________________________________

d. Shut off building heating equipment to remove load on hot water system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. _________________________________________________________

2. Verify boiler inlet/outlet pressure reading, compare to Test and Balance (TAB) Report, boiler design conditions, and boiler manufacturer's performance data.

| | DESIGN | SYSTEM TEST | ACTUAL |
|---|---|---|---|
| Boiler inlet pressure (kPa gauge) | __________ | _________ | __________ |
| Boiler outlet pressure (kPa gauge) | __________ | _________ | __________ |
| Boiler flow rate (L/s) | __________ | _________ | __________ |
| Flue-gas temperature at boiler outlet | | _________ | __________ |
| Percent carbon dioxide in flue-gas | | _________ | __________ |
| Draft at boiler flue-gas exit | | _________ | __________ |
| Draft or pressure in furnace | | _________ | __________ |
| Stack emission pollutants concentration | __________ | _________ | __________ |
| Fuel type | __________ | _________ | __________ |
| Combustion efficiency | __________ | _________ | __________ |

3. Record the following information:

| | | |
|---|---|---|
| Ambient temperature | __________ | degrees C |
| Entering hot water temperature | __________ | degrees C |
| Leaving hot water temperature | __________ | degrees C |

4. Verify temperatures in item 3 are in accordance with the reset schedule. ________________________________________________________________

5. Verify proper operation of boiler safeties. __________________________

6. Unusual vibration, noise, etc.

Functional Performance Test Checklist - Hot Water Boiler

For Boiler: All

7. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement. ____________________

8. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

| | Signature and Date |
|---|---|
| Contractor's Chief Quality Control Representative | ____________________ |
| Contractor's Mechanical Representative | ____________________ |
| Contractor's Electrical Representative | ____________________ |
| Contractor's Testing, Adjusting and Balancing Representative | ____________________ |
| Contractor's Controls Representative | ____________________ |
| Contracting Officer's Representative | ____________________ |
| Using Agency's Representative | ____________________ |

Functional Performance Test Checklist - Unit Heaters

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent.

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Changes to be heating set point to heating set point minus 10 degrees and return to heating set point. ___________________________________

b. Check blower fan speed. _______________________________________rpm

c. Check heating mode inlet air temperature. _____ degrees C Check heating mode inlet air temperature.

d. Check heating mode outlet air temperature. _____ degrees C Check heating mode outlet air temperature.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

| | Signature and Date |
|---|---|
| Contractor's Chief Quality Control Representative | _____________________________ |
| Contractor's Mechanical Representative | _____________________________ |
| Contractor's Electrical Representative | _____________________________ |
| Contractor's Testing, Adjusting and Balancing Representative | _____________________________ |
| Contractor's Controls Representative | _____________________________ |
| Contracting Officer's Representative | _____________________________ |
| Using Agency's Representative | _____________________________ |

Functional Performance Test Checklist - HVAC Controls

For HVAC System: All

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed 10 percent.

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

Sensor ___________________________________________
Manual measurement _______________________________
Panel reading value ______________________________

c. Verify system stability by changing the controller set point as follows:

(1) Air temperature - 10 degrees F

(2) Water temperature - 10 degrees F

(3) Static pressure - 10 percent of set point

(4) Relative humidity - percent (RH)

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

d. Verify interlock with other HVAC controls.

e. Verify interlock with fire alarm control panel.

f. Verify interlock with EMCS.

g. Change controller set point 10 percent with EMCS and verify correct response.

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Functional Performance Test Checklist - HVAC Controls

For HVAC System: All

| | Signature and Date |
|---|---|
| Contractor's Chief Quality Control Representative | ______________________ |
| Contractor's Mechanical Representative | ______________________ |
| Contractor's Electrical Representative | ______________________ |
| Contractor's Testing, Adjusting and Balancing Representative | ______________________ |
| Contractor's Controls Representative | ______________________ |
| Contractor's Officer's Representative | ______________________ |
| Using Agency's Representative | ______________________ |

-- End of Section --

# SECTION 16375

# ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C119.1 | (1986; R 1997) Sealed Insulated Underground Connector Systems Rated 600 Volts |
| ANSI C29.1 | (1988; R 1996) Electrical Power Insulators - Test Methods |
| ANSI C57.12.21 | (1995) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller) |
| ANSI C57.12.26 | (1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVA and Smaller |
| ANSI C80.1 | (1995) Rigid Steel Conduit - Zinc Coated |
| ANSI O5.1 | (1992) Specifications and Dimensions for Wood Poles |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A 123/A 123M | (2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 153/A 153M | (2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 48M | (1994e1) Gray Iron Castings (Metric) |

| | |
|---|---|
| ASTM B 117 | (1997) Operating Salt Spray (Fog) Apparatus |
| ASTM B 3 | (1995) Soft or Annealed Copper Wire |
| ASTM B 496 | (1999) Compact Round Concentric-Lay-Stranded Copper Conductors |
| ASTM B 8 | (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM C 478 | (1997) Precast Reinforced Concrete Manhole Sections |
| ASTM C 478M | (1997) Precast Reinforced Concrete Manhole Sections (Metric) |
| ASTM D 1654 | (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments |
| ASTM D 4059 | (1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography |
| ASTM D 923 | (1997) Sampling Electrical Insulating Liquids |

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

| | |
|---|---|
| AEIC CS5 | (1994; CS5a-1995) Cross-Linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV |
| AEIC CS6 | (1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV |

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

| | |
|---|---|
| FM P7825a | (1998) Approval Guide Fire Protection |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (1997) National Electrical Safety Code |
| IEEE C57.12.00 | (1993) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C62.1 | (1989; R 1994) Surge Arresters for AC Power Circuits |
| IEEE C62.11 | (1999) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits |

| | |
|---|---|
| IEEE C62.2 | (1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems |
| IEEE Std 386 | (1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V |
| IEEE Std 404 | (1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V Through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V |
| IEEE Std 48 | (1998) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV |
| IEEE Std 592 | (1990; R 1996) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors |
| IEEE Std 81 | (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) \$31.00$\F |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA FB 1 | (1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies |
| NEMA LA 1 | (1992) Surge Arresters |
| NEMA TC 6 | (1990) PVC and ABS Plastic Utilities Duct for Underground Installation |
| NEMA WC 7 | (1988; Rev 3 1996) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy |
| NEMA WC 8 | (1988; Rev 3 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2002) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1242 | (1996; Rev Mar 1998) Intermediate Metal Conduit |
| UL 467 | (1993; Rev thru Apr 1999) Grounding and Bonding Equipment |
| UL 486A | (1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors |
| UL 486B | (1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors |
| UL 510 | (1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape |
| UL 514A | (1996; Rev Dec 1999) Metallic Outlet Boxes |
| UL 6 | (1997) Rigid Metal Conduit |
| UL 651 | (1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit |

## 1.2 GENERAL REQUIREMENTS

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electrical Distribution System; G.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

a. Medium-voltage cables and accessories including cable installation plan.

b. Transformers.

c. Surge arresters.

As-Built Drawings.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

SD-03 Product Data

Nameplates.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; G.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

General Installation Requirements; G.

As a minimum, installation procedures for transformers, substations, switchgear, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-06 Test Reports

Factory Tests; G.

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing; G.

A proposed field test plan, 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests; G.

Six copies of the information described below in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Cable Installation; G.

Six copies of the information described below in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with cable pulls numerically identified.

b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

c. The cable manufacturer and type of cable.

d. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pull and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Material and Equipment; G.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

Cable Joints; G.

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

Cable Installer Qualifications; G.

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than 25 mm in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

# PART 2 PRODUCTS

## 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

## 2.2 NAMEPLATES

### 2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

### 2.2.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided with nameplate information in accordance with IEEE C57.12.00. Nameplates shall indicate the number of liters and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 2 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 2 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

## 2.3 CORROSION PROTECTION

### 2.3.1 Aluminum Materials

Aluminum shall not be used.

### 2.3.2 Ferrous Metal Materials

#### 2.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

#### 2.3.2.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm (1/16 inch) from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTS AND COATINGS.

2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

2.4.1 Medium-Voltage Cables

2.4.1.1 General

Cables shall be manufactured for use in duct applications as indicated.

2.4.1.2 Ratings

Cables shall be rated for a circuit voltage of 15 kV.

2.4.1.3 Conductor Material

Underground cables shall be soft drawn copper complying with ASTM B 3 and ASTM B 8 for regular concentric and compressed stranding or ASTM B 496 for compact stranding.

2.4.1.4 Insulation

Cable insulation shall be ethylene-propylene-rubber (EPR) insulation conforming to the requirements of NEMA WC 8 and AEIC CS6. A 133 percent insulation level shall be used on 5 kV, 15 kV and 25 kV rated cables. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

2.4.1.5 Shielding

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase.

2.4.1.6 Neutrals

Neutral conductors of shall be copper. employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.

2.4.1.7 Jackets

Cables shall be provided with a polyethylene jacket. Direct buried cables shall be rated for direct burial.

2.4.2 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

2.4.2.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8.

2.4.2.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

2.4.2.3 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70.

2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

2.5.1 Medium-Voltage Cable Joints

Medium-voltage cable joints shall comply with IEEE Std 404 and IEEE Std 592. Medium-voltage cable terminations shall comply with IEEE Std 48. Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits may be of the heat-shrinkable type for voltages up to 15 kV, of the premolded splice and connector type, the conventional taped type, or the resin pressure-filled overcast taped type for voltages up to 35 kV; except that for voltages of 7.5 kV or less a resin pressure-filled type utilizing a plastic-tape mold is acceptable. Joints used in manholes, handholes, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

2.5.2 Medium-Voltage Separable Insulated Connectors

Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

2.5.3 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2.5.4 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

2.5.4.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level. Leakage distances shall comply with wet withstand voltage test requirements of IEEE Std 48 for the next higher Basic Insulation Level (BIL) level.

2.5.4.2 Taped Terminations

Taped terminations shall use standard termination kits providing terminal connectors, field-fabricated stress cones, and rain hoods. Terminations shall be at least 510 mm long from the end of the tapered cable jacket to the start of the terminal connector, or not less than the kit manufacturer's recommendations, whichever is greater.

2.6 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application. Duct lines shall be concrete-encased, thin-wall type for duct lines between manholes and for other medium-voltage lines. Low-voltage lines run elsewhere may be direct-burial, thick-wall type.

### 2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

### 2.6.2 Nonmetallic Ducts

#### 2.6.2.1 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

#### 2.6.2.2 Direct Burial

UL 651 Schedule 40, or NEMA TC 6 Type DB.

### 2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 2 degrees C (35 degrees F), shall neither slump at a temperature of 150 degrees C (300 degrees F), nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

## 2.7 MANHOLES, HANDHOLES, AND PULLBOXES

Manholes, handholes, and pullboxes shall be as indicated. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48M , Class 30B, minimum. Pullbox and handhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

## 2.8 POLES AND HARDWARE

Poles and hardware shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

## 2.9 TRANSFORMERS, SUBSTATIONS, AND SWITCHGEAR

Transformers, substations, and switchgear shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 15 kV between phases for 133 percent insulation level.

### 2.9.1 Pad-Mounted Transformers

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the loop feed type. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with provisions for a padlock. [AM#1] <u>Transformer windings shall be copper.</u>

#### 2.9.1.1 High-Voltage Compartments

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, oil-immersed, current-limiting, bayonet-type fuses, medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. [AM#1] ____________________________________________________. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on a second set of high voltage bushings.

#### 2.9.1.2 Load-Break Switch

Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment. Operation of switches shall be as follows:

| ARRANGEMENT # | DESCRIPTION OF SWITCH ARRANGEMENT | SWITCH POSITION LINE A SW OPEN | LINE A SW CLOSE | LINE B SW OPEN | LINE B SW CLOSE | XFMR SW OPEN | XFMR SW CLOSE |
|---|---|---|---|---|---|---|---|
| 1 | Line A connected to | | X | | X | | X |

| ARRANGEMENT # | DESCRIPTION OF SWITCH ARRANGEMENT | SWITCH POSITION LINE A SW OPEN CLOSE | LINE B SW OPEN CLOSE | XFMR SW OPEN CLOSE |
|---|---|---|---|---|
| | Line B and both lines connected to transformer | | | |
| 2 | Transformer connected to Line A only | X | X | X |
| 3 | Transformer connected to Line B only | X | X | X |
| 4 | Transformer open and loop closed | X | X | X |
| 5 | Transformer open and loop open | X | X | X |

2.9.1.3 Transformer Tank Sections

Transformers shall comply with IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the mineral oil-insulated type. Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2 above and 2 below rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity.........................................1500 kVA.

Impedance.......................................................5.8%.

Temperature Rise.......................................65 degrees C.

High-voltage winding...................................12,470 volts.

High-voltage winding connections..............................Delta.

Low-voltage winding..................................277/480 volts.

Low-voltage winding connections................................. Wye

2.9.1.4 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

#### 2.9.1.5 Accessories

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Dial-type thermometer, liquid-level gauge, and drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

## 2.10 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1, IEEE C62.1, IEEE C62.2, and IEEE C62.11 and shall be provided where indicated. Arresters shall be distribution class. Arresters for use at elevations in excess of 1.8 km (6000 feet) above mean sea level shall be specifically rated for that purpose. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the valve or metal-oxide varistor or combination valve-metal-oxide varistor type.

## 2.11 GROUNDING AND BONDING

### 2.11.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 not less than 19 mm (3/4 inch) in diameter by 3.1 m (10 feet) in length. Sectional type rods may be used.

### 2.11.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

## 2.12 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200 CONCRETE REINFORCEMENT.

## 2.13 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825a as a fire-protective coating or tape approved for grouped electrical conductors and shall be suitable for application on the type of medium-voltage cables provided. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.

#### 2.13.1 Fireproof Coating

Cable fireproofing coatings shall be compounded of water-based thermoplastic resins, flame-retardant chemicals, and inorganic noncombustible fibers and shall be suitable for the application methods used. Coatings applied on bundled cables shall have a derating factor of less than 5 percent, and a dielectric strength of 95 volts per mil minimum after curing.

#### 2.13.2 Fireproofing Tape

Fireproofing tape shall be at least 50 mm (2 inches) wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

#### 2.13.3 Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 0.254 mm (10 mil) thick, conforming to UL 510.

### 2.14 LIQUID DIELECTRICS

Liquid dielectrics for transformers, capacitors, reclosers, and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than 2 parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding 2 ppm shall be replaced.

### 2.15 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

a. Transformers: Manufacturer's standard routine design and other tests in accordance with IEEE C57.12.00.

b. Factory Preformed Terminations: Wet withstand voltage tests in accordance with IEEE Std 48 for the next higher BIL level.

c. Electrical Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed aerially shall conform to the requirements of Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

#### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 3.1.3 Disposal of Liquid Dielectrics

PCB-contaminated dielectrics must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectrics shall not be diluted to lower the contamination level.

### 3.2 CABLE AND BUSWAY INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then prepare a checklist of significant requirements which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

#### 3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

#### 3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

#### 3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 6.4 mm (1/4 inch) less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 131 cubic centimeters (8 cubic inches) of debris is expelled from the duct.

#### 3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

#### 3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 10 degrees C (50 degrees F) temperature for at least 24 hours before installation.

#### 3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall thrust pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

#### 3.2.2 Duct Line

Cables shall be installed in duct lines where indicated. Cable joints in medium-voltage cables shall be made in manholes or approved pullboxes only. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

#### 3.2.3 Electric Manholes

Cables shall be routed around the interior walls and securely supported from walls on cables racks. Cable routing shall minimize cable crossover, provide access space for maintenance and installation of additional cables, and maintain cable separation in accordance with IEEE C2.

### 3.3 CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

### 3.4 FIREPROOFING

Each medium-voltage cable and conductor in manholes shall be fire-proofed for their entire length within the manhole. Where cables and conductors have been lubricated to enhance pulling into ducts, the lubricant shall be removed from cables and conductors exposed in the manhole before fireproofing. Fire-stops shall be installed in each conduit entering or leaving a manhole.

#### 3.4.1 Tape Method

Before application of fireproofing tape, plastic tape wrapping shall be applied over exposed metallic items such as the cable ground wire, metallic outer covering, or armor to minimize the possibility of corrosion from the fireproofing materials and moisture. Before applying fireproofing tape, irregularities of cables, such as at cable joints, shall be evened out with insulation putty. A flexible conformable polymeric elastomer fireproof tape shall be wrapped tightly around each cable spirally in 1/2 lapped wrapping or in 2 butt-jointed wrappings with the second wrapping covering the joints of the first.

#### 3.4.2 Sprayable Method

Manholes shall be power ventilated until coatings are dry and dewatered and the coatings are cured. Ventilation requirements shall be in accordance with the manufacturer's instruction, but not less than 10 air changes per hour shall be provided. Cable coatings shall be applied by spray, brush, or glove to a wet film thickness that reduces to the dry film thickness approved for fireproofing by FM P7825a. Application methods and necessary safety precautions shall be in accordance with the manufacturers instructions. After application, cable coatings shall be dry to the touch in 1 to 2 hours and fully cured in 48 hours, except where the manufacturer has stated that because of unusual humidity or temperature, longer periods may be necessary.

### 3.5 DUCT LINES

#### 3.5.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 100 mm per 30 m. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm (18 inches) for ducts of less than 80 mm (3 inch) diameter, and 900 mm (36 inches) for ducts 80 mm (3 inches) or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

#### 3.5.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

### 3.5.3 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 150 mm (6 inches) in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface loadings. Tops of concrete encasements shall be not less than 1.5 m below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 150 mm vertically.

### 3.5.4 Nonencased Direct-Burial

Top of duct lines shall be not less than 60 mm below finished grade and shall be installed with a minimum of 75 mm of earth around each duct, except that between adjacent electric power and communication ducts, 300 mm of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 75 mm layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least1 50 mm. The first 150 mm layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 75 to 150 mm layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

### 3.5.5 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

#### 3.5.5.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

## 3.6 MANHOLES, HANDHOLES, AND PULLBOXES

### 3.6.1 General

Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 15 mm above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

### 3.6.2 Electric Manholes

Cables shall be securely supported from walls by hot-dip galvanized cable racks with a plastic coating over the galvanizing and equipped with adjustable hooks and insulators. The number of cable racks indicated shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks.

### 3.6.3 Communications Manholes

The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each telephone manhole. Each cable rack shall be provided with 2 cable hooks. Cables for the telephone and communication systems will be installed by others.

#### 3.6.4 Ground Rods

A ground rod shall be installed at the manholes, handholes and pullboxes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 100 mm of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

### 3.7 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose.

#### 3.7.1 Concrete Pads

##### 3.7.1.1 Construction

Concrete pads for pad-mounted electrical equipment shall be poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 100 mm above finished paving or grade and sloped to drain. Edges of concrete pads shall have 20 mm chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

##### 3.7.1.2 Concrete and Reinforcement

Concrete work shall have minimum 20 MPa compressive strength and comform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200 CONCRETE REINFORCEMENT.

##### 3.7.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

## 3.8 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than 3 m apart and with 1 strap not more than 300 mm from any bend or termination. Cable guards shall be secured to poles in accordance with the manufacturer's published procedures. Conduits shall be equipped with bushings to protect cables and minimize water entry. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable. Cables shall be supported by devices separate from the conduit, near their point of exit from the conduit.

### 3.8.1 Pole Installation

Pole installation shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

## 3.9 GROUNDING

A ground ring consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from a transformer to the ground ring. Metallic frames and covers of handholes and pull boxes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

### 3.9.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 300 mm below finished grade.

b. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed 300 mm, plus or minus 75 mm, below finished top of soil grade. Ground ring conductors shall be No. [AM#1] __ 1/0 AWG, minimum.

c. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors to achieve the specified ground resistance. The additional electrodes will be up to three,3 m (10 feet) rods spaced a minimum of 3.7 m apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

### 3.9.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

### 3.9.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

### 3.9.4 Surge Arrester Grounding

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

### 3.9.5 Manhole, Handhole, or Concrete Pullbox Grounding

Ground rods installed in manholes, handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 50 mm above and 150 mm below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

### 3.9.6 Riser Pole Grounding

A single continuous vertical grounding electrode conductor shall be installed on each riser pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, neutrals, surge arresters, and items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 600 mm.

## 3.10 FIELD TESTING

### 3.10.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 14 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

### 3.10.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.10.3 Ground-Resistance Tests

The resistance of the ground ring shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Ground ring - 25 ohms.

### 3.10.4 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, except that 28 kV and 35 kV insulation test voltages shall be in accordance with either AEIC CS5 or AEIC CS6 as applicable, and shall not exceed the recommendations of IEEE Std 404 for cable joints and IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.10.5 Liquid-Filled Transformer Tests

The following field tests shall be performed on all liquid-filled transformers. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

c. Correct phase sequence.

d. Correct operation of tap changer.

3.10.6 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the installation shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

a. Pad-mounted transformers

b. Switches

3.10.7 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

## 3.11 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

# SECTION 16770

# PUBLIC ADDRESS SYSTEMS
**04/02**
**AMENDMENT NO. 0001**

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

| | |
|---|---|
| EIA ANSI/EIA-310-D | (1992) Cabinets, Racks, Panels, and Associated Equipment |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2002) National Electrical Code |

### 1.2 SYSTEM DESCRIPTION

The public address system shall consist of an audio distribution network to include amplifiers, mixers, microphones, speakers, cabling, and ancillary components required to meet the required system configuration and operation.

#### 1.2.1 Multiple Zone System

The system shall control and amplify an audio program for zone distribution within the areas indicated. Components of the system shall include input panels, digital signal process mixer/router controller, power amplifier, speaker systems, cabling and other associated hardware.

#### 1.2.2 System Performance

The system shall provide even sound distribution throughout the designated area, plus or minus 3 dB from 100 Hz to 6 khz. The system shall provide uniform frequency response throughout the designated area, plus or minus 3 dB as measured with 1/3-octave bands of pink noise at locations across the designated area selected by the Contracting Officer. The system shall be capable of delivering 90 dB average program level with additional 10 dB peaking margin sound pressure level (SPL) in the area at an acoustic distortion level below 5 percent total harmonic distortion (THD). Unless otherwise specified the sound pressure reference level is 20 micro Pascal (0.00002 Newtons per square meter).

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Public Address System; G, ED.

Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical speakers. The Contractor shall check the layout based on the actual speakers to be installed and make necessary revisions in the detail drawings. Detail drawings shall also contain complete point to point wiring, schematic diagrams and other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-03 Product Data

Spare Parts; G.

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-06 Test Reports

Approved Test Procedures; G.

Test plan and test procedures for the acceptance tests. The test plan and test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedure shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance.

Acceptance Tests; G.

Test reports in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The reports shall include the manufacturer, model number, and serial number of test equipment used in each test. Each report shall indicate the final position of controls and operating mode of the system.

SD-07 Certificates

Components; G.

Copies of current approvals or listings issued by UL, or other nationally recognized testing laboratory for all components.

SD-10 Operation and Maintenance Data

Public Address and reinforcement System, Data Package 3; G
.

{AM#0001}__________________________

1.4 DELIVERY AND STORAGE

Equipment placed in storage until installation shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.5 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with the details of the work and working conditions, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancies before performing the work.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Material and equipment to be provided shall be the standard products of a manufacturer regularly engaged in the manufacture of such products, and shall essentially duplicate material and equipment that have been in satisfactory use at least 2 years. All components used in the system shall be commercial designs that comply with the requirements specified. Equipment shall be supported by a service organization that is within 200 miles of the site.

2.1.1 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.1.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, model and catalog number, and serial number on a plate secured to the equipment.

2.2 DIGITAL SIGNAL PROCESSOR MIXER/ROUTER/CONTROLLER

2.2.1 Function of the Signal Processor

Shall be to provide multiple input mixing to multiple outputs with equalization, delay, limiting, volume control, routing and control.

2.2.2 Features

- minimum of 12 inputs configurable as mic or line level. 4 inputs shall be dual channel line level, 8 inputs shall be mic or line level programmable.
- minimum of 10 outputs, balanced.
- equalization for each output.
- limiting for each output.
- routing control of inputs to outputs.
- priority override input which ducks.
- other inputs.
- remote push button control.
- supply voltage of 120VAC.
- internal headroom of +15dB
- maximum output level of +16dBu.
- frequency response of 20Hz to 20kHz +/- 1dB.
- distortion (THD) better than 0.004% at 1kHz
- noise of -80dBu
- ADC convertor of 24-BIT Fs x 128 S-D
- DAC convertor of 20-BIT Fs x 128 S-D
- processing 24-BIT fixed point.
- sampling frequency of 48 kHz

2.2.3 Acceptable

- BIAMP systems Audio (multiple)
- Allen Heath DR128 (multiple)
- Peavy Media match.

2.3 POWER AMP PA 200-70.7

2.3.1 Dual Channel Power

Amp with minimum rating of 200 watts per channel and 70.7 volt output.

2.3.2 Features

- Dual channel.
- 200 watts per channel at 70.7 volt.
- minimum frequency response of 20 to 20 kHz.
- maximum distortion of 0.01% THD.
- noise at 20 to 20 kHz of less than -106dB.
- Gain at 8 ohms of 35dB.
- input unbalanced: 6 kohms unbalanced, 12 kohms balanced, minimum.
- amplifier protection: Short circuit, open circuit, thermal, ultrasonl, RF.
- cooling shall be fan assisted.

2.3.3 Acceptable

- QSC model CX302V
- Equal by crown
- equal by crest

2.4 LOUDSPEAKERS

2.4.1 Flush Mount Ceiling Speaker Type "S1"

- Flush mount ceiling speaker with integral back box and grill.
- 100 mm diameter woofer with butyl rubber surround and 19 mm
- Frequency range of 80 hZ to 20khX.
- Sensitivity of 86dB SPL at 1 watt, 1 meter.
- Nominal impedance: 16 ohms.
- 70.7 volt transformer taps.
- 3.7 w, 7.5 w, 15 w, 30 w.
- Fire rates steel back box U.L. 2043 listed for plenum spaces.

2.4.1.1 Acceptable

- JBL model 24 CT.
- Equal by Bose (w/processor).
- Equal by actel lansing.

2.4.2 Horn Speaker

The horn speaker shall as a minimum conform to the following specifications:

| | |
|---|---|
| Application: | Indoor |
| Frequency Response: | 400 - 14,000 Hz |
| Power Taps: | 70 volt line - .9, 1.8, 3.8, 7.5, and 15 watts |
| Impedance: | 5000, 2500, 1300, 670, 330, 90, and 45 ohms |
| Power Rating: | Normal - 7 watts<br>Peak - 15 watts |
| Dispersion: | 110 degrees |

2.5 SWITCHES AND CONTROLS

2.5.1 Remote Loudspeaker Volume Controls

Remote volume controls shall be an auto transformer type with detented 3 dB steps and an OFF position. The controls shall be wall-mounted in single-gang outlet boxes and furnished with engraved switching plates finished to match approved finish of electrical wall switches. Insertion loss of the controls shall not exceed 0.6 dB and the power-handling capacities of the control shall be 35 or 100 watts as shown on drawings. Low-voltage priority override relays shall be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

## 2.6 EQUIPMENT RACKS

Equipment shall be mounted on 482.6 mm (19 inch) racks in accordance with EIA ANSI/EIA-310-D and located as shown on drawings. Ventilated rear panels, solid side panels, and solid top panels shall be provided. Equipment racks shall be provided with lockable front panels that limit access to equipment. The lockable front shall not cover items that require operator access such as am/fm tuner, CD player, or tape player. Rack cooling shall be through perforations or louvers in front panels to ensure adequate ventilation of equipment. The racks and panels shall be factory finished with a uniform baked enamel over rust inhibiting primer.

## 2.7 CABLES

### 2.7.1 Speaker Cable

Cables shall be of the gauge required depending upon the cable run length. In no case shall cable be used which is smaller than 18 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm (0.009 inch). Cables shall be jacketed with a PVC compound. The jacket thickness shall be 0.5 mm (0.02 inch) minimum. Speaker cable shall be routed in conduit.

### 2.7.2 Microphone and Line Level Cable

Cable conductor shall be stranded copper 20 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm (0.009 inch). Cable shall be shielded 100% of aluminum polyester foil with a bare 22 gauge stranded soft copper drain conductor. Cables shall be jacketed with a PVC compound. The jacket thickness shall be 0.5 mm (0.02 inch) minimum. Cables shall be routed in conduit.

## 2.8 TERMINALS

Terminals shall be solderless, tool-crimped pressure type.

## 2.9 SURGE PROTECTION

### 2.9.1 Power Line Surge Protection

Major components of the system such as power amplifiers, mixer-preamplifiers, and tuners, shall have a device, whether internal or external, which provides protection against voltage spikes and current surges originating from commercial power sources per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground). Surge protection device shall be UL listed & labeled as having been tested in accordance with UL 1449.

### 2.9.2 SIGNAL SURGE PROTECTION

Major components of the system shall have internal protection circuits which protects the component from mismatched loads, direct current, and shorted output lines. Communication cables/conductors shall have surge protection installed at each point where it exits or enters a building.

## 2.10 TELEPHONE INTERFACE MODULE

Telephone Interface module shall provide one way all call paging access from telephone to PA system. Paging shall be accomplished by the building telephone system instruments interconnected to the PA system via an interface module to allow telephone dial up access to the paging amplifier. Interface module shall produce an alert tone in the associated speakers on activation. Telephone interface module shall as a minimum conform to the following specifications:

| | |
|---|---|
| Impedance: | 600 ohms |
| Frequency response: | 100Hz to 10Khz |
| Output level: | 400mV rms |
| Input Power Requirement: | 12-24Vdc (from power supply) |
| Access requirement: | Electronic (analog) or IA2 line key (line card required) PABX loop or ground-start trunk port, or dedicated single-line phone. |

# PART 3 EXECUTION

## 3.1 INSTALLATION

Equipment shall be installed as indicated and specified, and in accordance with the manufacturer's recommendations except where otherwise indicated. Equipment mounted in pool areas shall be weatherproofed.

### 3.1.1 Equipment Racks

Racks shall be mounted side-by-side and bolted together. Items of the same function shall be grouped together, either vertically or side-by-side. Controls shall be symmetrically arranged at a height as shown. Audio input and interconnections shall be made with approved shielded cable and plug connectors; output connections may be screw terminal type. All connections to power supplies shall utilize standard male plug and female receptacle connectors with the female receptacle being the source side of the connection. Inputs, outputs, interconnections, test points, and relays shall be accessible at the rear of the equipment rack for maintenance and testing. Each item shall be removable from the rack without disturbing other items or connections. Empty space in equipment racks shall be covered by blank panels so that the entire front of the rack is occupied by panels.

### 3.1.2 Wiring

Wiring shall be installed in rigid steel conduit, intermediate metal conduit, or electric metallic tubing as specified in Section 16415A ELECTRICAL WORK, INTERIOR. Wiring for microphone, grounding, line level, speaker and power cables shall be isolated from each other by physical isolation and metallic shielding. Shielding shall be terminated at only one end.

## 3.2 GROUNDING

All grounding practices shall comply with NFPA 70. Equipment shall be grounded to the serving panelboard ground bus through a green grounding conductor. Metallic conduits serving the equipment shall be isolated on the equipment end with a insulating bushing to prevent noise from being transferred to the circuit. Equipment racks shall be grounded to the panelboard ground bus utilizing a #2 conductor. Grounding conductor shall be terminated to the rack using connector suitable for that purpose.

## 3.3 ACCEPTANCE TESTS

After installation has been completed, the Contractor shall conduct acceptance tests, utilizing the approved test procedures, to demonstrate that equipment operates in accordance with specification requirements. The Contractor shall notify the Contracting Officer 14 days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written Contracting Officer approval of the test plans as specified. The acceptance tests shall include originating and receiving messages at specified stations, at proper volume levels, without cross talk or noise from other links or nondesignated units.

## 3.4 TRAINING

The Contractor shall conduct a training course for 4 members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of 4 hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance manuals, as well as demonstrations of routine maintenance operations. The Contracting Officer shall be notified at least 14 days prior to the start of the training course.

-- End of Section --